



Vaasan yliopisto
UNIVERSITY OF VAASA

Aleksi Aaltonen

Strategic Impact of Environmental Regulation on Competitive Advantage

Case: RED III Directive and Andritz e-Fuels

School of Management
Master's thesis in Strategic
Business Development

Vaasa 2025

UNIVERSITY OF VAASA**School of Management**

Author: Aleksi Aaltonen
Title of the Thesis: Strategic Impact of Environmental Regulation on Competitive Advantage : Case: RED III Directive and Andritz e-Fuels
Degree: Master of Science in Economics and Business Administration
Program: Strategic Business Development
Supervisor: Marko Kohtamäki
Year: 2025 **Pages:** 108

ABSTRACT:

Aim: The climate change presents a holistic challenge to fossil energy consumption requiring adaptation of renewables where renewable hydrogen's role is evitable. Regulation provides the basis of business in the green transition and companies recognizing their regulatory position can gain competitive advantage. While environmental regulation is well studied in economics, its role in strategic management remains unexplored. This study explores how environmental regulation shapes firm strategy and business model innovation (BMI), altogether competitive advantage in the renewable hydrogen industry.

Methodology: the study adopts a qualitative case study. The thesis consists of both an empirical study based on the existing theory for academia and novel findings, as well as a practical business development case. Literature is reviewed from business models, business model innovation and environmental regulation with their perspectives on competitive advantage. The **empirical results** are conducted with a case study approach, drawing on 12 semi-structured interviews conducted with professionals in the renewable hydrogen regulation and business. Furthermore, the Gioia method was utilized to induce the rich qualitative results, with addition of context analysis of renewable fuels of non-biological origin (RFNBO) regulation and value system.

Results: The findings indicate that regulation functions as the market-forming antecedent: it creates the offtake basis of the whole RFNBO industry, there by setting boundary conditions for firm actions and gaining competitive advantage. The findings develop a concept of regulatory position as a two-sided strategic variable for high context regulatory driven industries. First, focal firm's strategy and regulation are interlinked, how firms engage in business in relation to focal regulation. Secondly, understanding value system's relevant regulation indicates predictability on market opportunities and risk level anticipation.

Theoretically, this study's contributions lie in examining regulation as a moderator of different steps in the process of gaining competitive advantage between strategy, BMI and performance. For **managers**, the findings on regulation's strategic impact may enable managers to better understand how regulation impacts hydrogen value systems' development and develop their firms' strategic orientation with regulation. For **policy makers**, the study advocates regulation's impact for business and investment decisions by highlighting the importance of trustworthiness on policies defining bankability of renewable energy solutions.

KEYWORDS: Competitive advantage; Regulation; Business model innovation; Renewable hydrogen; e-Fuel; Strategy; P2X value chain

Contents

1	Introduction	7
1.1	Research gap	8
1.2	Research question, objectives and structure	10
2	Theoretical background	12
2.1	Business model	12
2.1.1	Business model elements	17
2.1.2	EPC business model	20
2.2	Environmental Regulation	21
2.2.1	Environmental regulation	21
2.2.2	Regulation's effect and firm responses	22
2.3	Business model innovation	24
2.4	Theoretical framework – synthesis	30
3	Methodology	32
3.1	Philosophical assumptions	32
3.2	Research method	33
3.3	Research strategy	34
3.4	Case and data	35
3.4.1	Case industry and company	35
3.4.2	Data collection	36
3.4.3	Data analysis	39
3.5	Validity and reliability	42
4	Findings	44
4.1	Context	44
4.1.1	RFNBO regulation	45
4.1.2	RFNBO value system	50
4.2	Regulation's meaning	57
4.2.1	Antecedent of innovation	57
4.2.2	Regulation's challenges	60

4.3	Regulation's strategic impact	64
4.3.1	Firm strategy	64
4.3.2	Business model and regulation	72
4.4	Summary of the results	80
5	Discussion	82
5.1	Theoretical contribution	82
5.2	Managerial implications	84
5.3	Policy recommendations	85
5.4	Suggestion for future research	86
5.5	Limitations	87
	References	89
	Appendix	102
	Appendix 1. Reference guiding document	102
	Appendix 2. List of interviewees	104
	Appendix 3. Interview questions and guide - general	104
	Appendix 4. Secondary data sources	107
	Appendix 5. Cross-analysis matrix's example in Microsoft Excel	108

Figures

Figure 1. Research gap.	10
Figure 2. Measurements of BMI.	28
Figure 3. Strategic measuring of BMI.	29
Figure 4. BMI research model.	30
Figure 5. Theoretical framework.	31
Figure 6. Research onion.	32
Figure 7. Data structure.	41
Figure 8. Research steps.	43
Figure 9. RFNBO value system and regulation.	51
Figure 10. Total energy demand in transport.	53
Figure 11. P2X competition: across strategic groups.	56
Figure 12. Revised theoretical framework.	81

Tables

Table 1. Business model definitions.	14
Table 2. Regulation effects on competitiveness.	23
Table 3. BMI and competitive advantage definitions.	27

Abbreviations

AEL: Alkaline Electrolysis

BM: Business Model

BMI: Business Model Innovation

CAPEX: Capital Expenditure

CAGR: Compound Annual Growth Rate

CO₂: Carbon Dioxide

DA: Delegated Act

EC: The European Commission

EEA: European Economic Area

EPC: Engineering, Procurement and Construction

EU: The European Union

e-_: Electrolysis- (where applied to: fuel, methanol, ammonia or LNG)

GW: Gigawatt

H₂: Hydrogen

LC: Low carbon

LCO_o: Levelized cost of _o; product, electricity, technology, etc.

LNG: Liquid Natural Gas

MeOH: Methanol

MTA: Million Tons per Annum

Mtoe: Mega tonnes of oil equivalent

MW: Megawatt

SAF: Sustainable Aviation Fuel

SME: Small-Medium-size Enterprise

RFNBO: Renewable Fuel of Non-Biological Origin

RED: Renewable Energy Directive (of the European Parliament, Directives 2023/2413).

PEM: Proton Exchange Membrane

PPA: Power-Purchase-Agreement

P2X: Power to Solution

USD: United States Dollar

1 Introduction

The global energy industry is going through an enormous change from the pressure of climate change and sustainable development. The European Parliament and the Council (EU) (2024a) released a revised version of the Renewable Energy Directive 2023/2413 (RED III) in November 2023 aiming to boost the competitiveness of the renewable energy solutions. The European Commission (2024a) targets to achieve 42,5% energy consumption from renewable sources by 2030 compared to the actual 24,5% share in 2023. For hydrogen and renewable fuels business, the RED III directive is a leading framework that pushes companies to invest in renewable hydrogen and fuels by mandating a minimum share obligation for distributors to supply Renewable Fuels of Non-Biological Origins (RFNBOs). The member states have relatively large freedom in defining the directive's legislation to local conditions, directing where and how the investments of renewable hydrogen plants are made, and how the demand for renewable hydrogen will evolve across Europe. Practically, RFNBOs are fuels derived with chemical link with hydrogen (EC, 2024a), defining a large scope in upstream production, but RFNBOs can include fuels derived with electricity as the energy carrier, e-Fuels. Particularly, e-Methanol as a downstream solution is promising solution for hard to abate sectors such as the maritime. Altogether, the European Union's regulation for sustainable transition poses cross-sectoral strategic impacts.

The transportation and energy industries are major sectors for overcoming the grand challenge presented by the climate change. The whole energy industry was responsible for 73,3% out of the global greenhouse gas (GHG) emissions which totaled at nearly 50 billion tons of carbon dioxide in 2020 (Richie, 2020). Specifically, the transport sector was responsible for 16,2%. The RED III directive mandates changes for the European transport and industry energy use since the renewable fuels are not economically competitive against fossil fuels yet, until political change (EC, 2024b). Furthermore, regulation lifts the demand to be at sufficient level with sufficient price (Giehl et al., 2023, 10356; Tholen et al., 2021, p. 5). However, the ramp-up of the green hydrogen economy requires collaboration of multiple sectors across its value chain consisting of renewable

energy sources, the oil and gas industry, and downstream end-use demand. Overall, market players that want to participate in the hydrogen trade and value chains of RFNBOs face regulation inevitably since regulation determines conditions on which business will be made. Therefore, understanding opportunities and challenges stakeholders face from regulation is vital for achieving competitive advantage in the renewable hydrogen industry.

The business model (BM) is dynamic approach to strategic management that has emerged into many fields and topics in the past decades. A common perspective is that the business model describes the earning logic of how value is captured from firm's value creation and delivery to the customer (Teece, 2018; Massa, 2024). Although, there is not an incumbent definition of BM among research (Massa et al., 2017; Zott et al., 2011), the literature tries to answer common themes of questions such as "how value is created", and "what is firm strategy based on the business model". Business model innovation (BMI) literature tries to answer questions "how does innovating BM sustain competitive advantage?" (Foss & Saebi, 2017, p. 201). Although demand side activities, customer understanding and knowledge offer sources of competitive advantage (Wirtz & Daiser, 2018; Teece, 2018), far less attention is given to regulation's impact. Especially, understanding customers requires understanding their regulatory context. Overall, business model and BMI literatures seem to have scarcity on regulation's role in gaining competitive advantage.

1.1 Research gap

A key question in strategic management literature throughout its various schools is why do some companies make exceptional profit over their rivals? Strategic management research such as positioning school (e.g., Michael Porter), as well as business model literature (e.g., Osterwalder & Pigneur, 2010; Amit & Zott, 2012), consider industry-wide forces' impact on competition. Firms unique positioning in its industry, and the industry's characteristics offer explanation for competitive advantage (Porter, 1991; Massa et al.,

2017, p. 95). The government and regulation act as catalyst igniting force for change (Porter; 1991), change in a firm's both external and internal factors results in system innovation (Shao et al., 2020). Economics study how environmental policies and regulation influence firm competitiveness (Fabrizi et al., 2024). While business model literature explores how value is created and captured from both supply and demand sides, there is a need to understand how these perspectives explain performance differences compared to traditional theories of value creation (Supply side -theory), that is how much industry ecosystem matters in explaining firm performance (Massa et al., 2017, p. 95).

This thesis examines how firms can gain competitive advantage amid emerging environmental regulation through a holistic case-study of the emerging renewable hydrogen-based fuels' industry. Kouamé and Langley (2018) suggest that recent strategy research emphasizes the importance of linking processes and practices to broader organizational outcomes in order to enhance managerial relevance. Following this reasoning, this study examines how stakeholder's interpretations of the emerging EU hydrogen regulations shape strategic decision making and business models at industry level. Research on renewable hydrogen in engineering, value chain studies, economics and policy are rising in numbers. However, strategic management studies regarding hydrogen regulation and industry are to be examined more. First, the thesis contributes by how firms can gain competitive advantage by understanding environmental regulation in the emerging renewable hydrogen industry. Second, the thesis explores regulation's strategic impact for the case company, Andritz. Thus, the **figure 1** presents an illustration of the research gap.

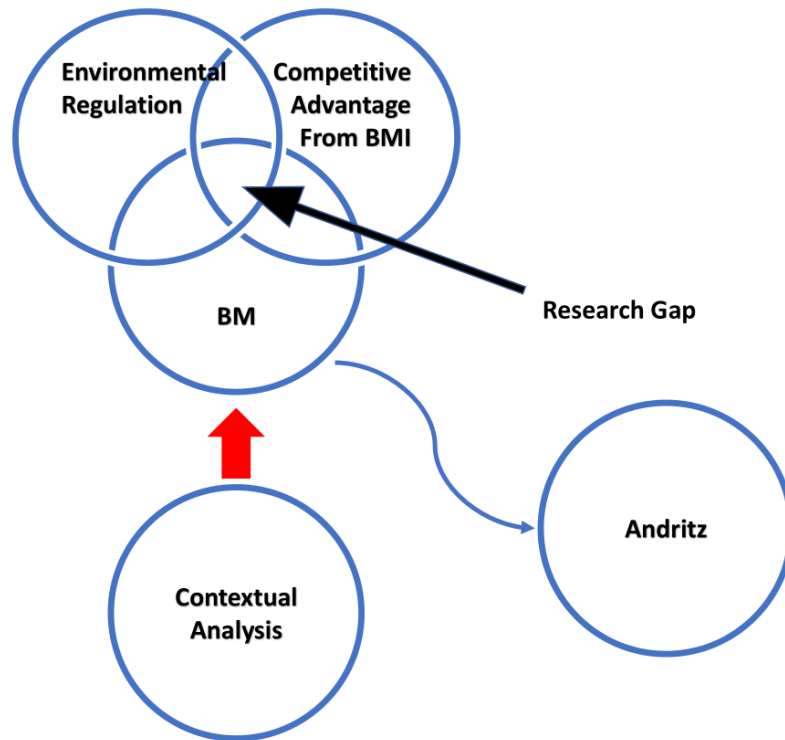


Figure 1. Research gap.

1.2 Research question, objectives and structure

Given the emerging status of, and the European Union's regulation for the RFNBO industry, this thesis explores how firms gain competitive advantage through business model innovation by understanding regulation. Thus, the research question:

RQ1: How does environmental regulation impact firm strategy, BMI and altogether competitive advantage in the renewable hydrogen industry?

The following research objectives are set to answer the research question and define an explicit scope:

1. To describe competitive advantage through business models and business model innovation literature.
2. To describe environmental regulation's influence on competitiveness, and thus competitive advantage.

3. To figure out the Renewable Energy Directive's RFNBO mandates' meaning for competitive advantage in the renewable hydrogen industry.
4. To identify key stakeholder and customer needs in the RFNBO value chain regarding regulation and evaluate how regulatory knowledge influences strategic positions by utilizing strategy tools (confidential).
5. To describe conclusions for Andritz's strategy and business (confidential).

The structure of the thesis divides into five main chapter. Following the introduction, the theoretical review focuses on competitive advantage of business models and business model innovation, as well as provides a review on environmental regulation theory. The third chapter, research methodology explains how the data is collected and analyzed. The fourth chapter begins first by presenting the contextual findings that are the regulatory analysis and the value chain analysis. Following the strategic analysis, the empirical findings are presented. The final chapter, discussion begins with theoretical contributions. The managerial implications are presented for the general public only, while Andritz's results are kept confidential. Policy recommendations are included, which is followed by suggestions of future research as well as limitations regarding the study and its subject.

2 Theoretical background

The literature review begins with review of business model (BM) literature. The BM literature review defines business model, how BM links to competitive advantage and its elements. The BM literature is followed by review of key theories in environmental regulation and compliance. Thirdly, business model innovation (BMI) literature explains how competitive advantage is sustained. Finally, a theoretical framework is synthesized to create a tool for solving the research question and problem.

2.1 Business model

When firms innovate and aim to bring new offerings to markets profitably, business models communicate the value creating procedures aligned with firm's strategy. Business models describe how value is created and delivered to customer and how part of the created value is captured in form of profit by the firm (Teece, 2010, p. 173; 2018). However, definition of business model is not as simple as stated in the previous sentences. The term has fragmented definition and meaning between different scholars (Zott et al., 2011; Bigelow & Barney, 2021; Ritter & Lettl, 2018), as well as varied interpretations (Massa et al., 2017). Ritter and Lettl (2018, p. 1) suggest business model is illustration on how firms position sets in industry's value chain and in which economic value is created, relating to the Resource-Based View -theory. Lanzolla and Markides (2021) state similar adoption of BM definition that BM bridges firms value creating and capturing activities between internal and external forces of a focal firm. Other common themes include that BM is an illustration of firm's strategy on how firm differentiates itself from rivals (Bigelow & Barney, 2021), as well as BM communicates how new innovations are commercialized (Zott et al., 2011), and business models as gateway to the sustainable transition (Aagaard, 2024; Bidmon & Knab, 2018, p. 904).

Although, the prior statement of fragmented definition for BM, scholars agree that business model describes at least how an organization functions and foremostly how it

creates and captures value (Bidmon & Knab, 2018; Massa, 2024). However, Bigelow and Barney (2021, p. 529) point out that the firm value creation definition resonates the most popular definition of strategy, positioning. Casadesus-Masanell and Ricart (2010) argue that BM is illustration of strategy, and strategy is not BM, but both resonate managerial choices. Teece (2010, p. 172) argues business model communicates the architecture of value creation, but not necessarily profit-oriented (Massa, 2024). The **table 1** presents business model definitions among scholars, each definition's theoretical lens, and articles' method are provided for comparison. Overall, BMs involve value creation, delivery, and capture, as well as strategic advantage, sustainability, commercializing innovation among other themes. For the thesis, business model is a strategic concept/instrument that communicates value creating, delivering and capturing activities of an organization, focal firm influenced by strategy. Therefore, BM means not just what firm offers, but how it offers it, to whom, and how value is monetized profitably, providing a distinct position from rivals. This aligns with perspectives from Teece (2010; 2018), and Zott and Amit (2007), forming a static picture of business yet dynamic with its elements.

Author(s) (Year, page)	Business model definition	Theoretical lens/perspective	Method
Lanzolla and Markides (2021, p. 542)	“an activity system that is centered on a focal firm and spans its internal/ external boundaries to bridge value creation and capturing”	Strategic management, system interdependencies between external and internal activities.	Theoretical discussion paper.
Zott et al. (2011, p. 1022)	“At a general level, [the BM] referred to as statement, a description, a representation, an architecture, a conceptual tool or model, a structural template, a method, a framework, a pattern, and a set.”	E-business (internet), strategy, innovation and technology management.	Literature review (1975-2009, 103 studies)
Teece (2010, p. 172)	“the design or architecture of the value creation, delivery, and capture mechanisms it employs.”	Strategic management. Meets particular customer need. Management’s hypothesis.	Landmark article. Concept discussion.
Teece (2018, p. 40)	“architecture for how a firm creates and delivers value to customer and the mechanism employed to capture a share of that value. It’s a matched set of elements encompassing the flows of costs, revenues, and profits.”	Dynamic capabilities influence towards BMs.	Conceptual theoretical synthesis.
Massa et al. (2017, p. 73)	“description of an organization and how that organization functions in achieving its goal (e.g., profitability, growth, social impact, ...)”	Question whether BM is new strategy. Point out the scope of lens when defining strategy and BM.	Landmark Literature Review.
Casadesus-Masanell and Ricart (2010, p. 196)	“the logic of the firm, the way it operates and how it creates value for its stakeholders--”	Interdependencies in activity system. Strategy is separate from BM.	Landmark article.
Chesbrough (2010, p. 355, adopted.)	Fulfills set list of functions: articulates value proposition, identifies market segment, defines value chain structure, details revenue mechanisms, estimates cost structure and profit potential, describes firm position among value system, and formulates strategy.	Strategic management. Open innovation. Activity and value system perspective, where BM is above these as overall concepts.	Case study of Xeros. Landmark article.
Ritter and Lettl, (2018, p. 1)	“a business model explains how an actor is positioned within a value network or supply chain, and how business turns inputs into outputs while fulfilling its goal.”	Strategic management. Theoretical mechanism. Review of five distinct perspectives on BM.	Discussion on earlier literature.
Bigelow and Barney (2021)	Discuss five conceptual definitions: activity system and value creation theory, BM as strategy implementation, monetization logic, organizing mechanism, and holistic view of all these together.	Conceptual, strategic management based on Resource-Based View. Contrasting strategy and BM perspectives	Comparative analysis of the BM concept.

Table 1. Business model definitions (Author’s interpretation).

The developments in business model literature divides to three distinct time periods according to Budler et al. (2021) in their bibliotic review. Originally the BM literature emerged on the internet-business boom in the 1990s to early-2000s (Budler et al., 2021; Zott et al., 2011). The second general theme in BM literature evolves around strategy and value creation, a holistic and system-level approach (Budler et al., 2021; Zott et al., 2011). Foremost, the second period involves consolidation of the BM paradigm (Budler et al., 2021). Thirdly, the most recent period includes BM research into new research communities outside strategic management, such as sustainability, industry 4.0 and networks, and BM's part in societal transition (Foss & Saebi, 2018, p. 9; Budler et al., 2021; Bidmon & Knab, 2018). In complementary, Foss and Saebi (2017, p. 202) state that the BM literature divides into three segments that are the business model as classification of business, BM as firm performance, and BM as unit of innovation. In their literature review, Zott et al. (2011, p. 1023) state the three main topics in which the BM literature studies are internet-business, strategy and competitive advantage, and thirdly, innovation and technology. In conclusion, the BM literature focuses on variety of topics and offers a lens to analyze contemporary themes for strategic management.

Industry recipes. In the traditional strategy positioning, value creation comes from supply side activities but in comparison the business model perspective involves demand side activities that allow value creation as well as interdependencies between activities (Massa et al., 2017, p. 75; Lanzolla & Markides, 2021, p. 550). In comparison, demand side consists of customers and other stakeholders down the value system that can participate in value creation. The **management's hypothesis** demonstrates what customers want, how they want it, and how companies can organize to deliver and capture those opportunities profitably (Teece, 2010). When firm's logic of operating repeats over time, dominant **business models' logic** form (Bidmon & Knab, 2018, p. 906), and moreover, firms' together form an **industry logic**. Overall, the industry logic recalls the archetype perspective of well-known and recognizable BM logics (e.g. Ritter & Lettl, 2018, p. 2-3). Managing competitive advantage through dominant logics should offer a tool of navigation similarly to as Porter (1991) argues on dynamic perspective of strategy. Therefore,

it is safe to argue BMs as logic of business mirror industry structure and forces, indicating focal industry's pathways for competition, thus improving competitive advantage.

Competitive advantage and business models: continuing on strategy perspective, scholars argue business model is illustration of strategy and how company positions itself uniquely from competition (Casadesus-Masanell & Ricart, 2010, p. 196; Bigelow & Barney, 2021, p. 531). Moreover, Bigelow and Barney point out the unique position perspective recalls Michael Porter that strategy is about trade-offs. Specifically, strategy means approach and position to market, and it dictates how the BM forms (Teece, 2010). Furthermore, tactics differentiate rivaling BMs in the constraint of the strategic positioning made initially (Casadesus-Masanell & Ricart, 2010). Controversially, scholars argue that a well-designed BM is itself a competitive advantage. Other perspectives include that BM's competitive advantage forms when hard to imitate (e.g., Teece, 2010, p. 173 & 180; 2018; Kindström, 2010, p. 481), when BM is innovation mechanism for differentiation (Amit & Zott 2012), or where BM is independent source of innovation yet influenced also by strategy (Heikkilä et al., 2018; Lanzolla & Markides, 2021). Overall, as much as BM offers a source for competitive advantage, it is influenced by strategic choices, tradeoffs and overall firm strategy.

However, industry positioning and strategy are not the only ways of looking at gaining competitive advantage. A second dominant perspective is the resource-based view (RBV) of firm that firm's unique resources create competitive advantage (Massa et al., 2017; Lanzolla & Markides, 2021). The RBV theory suggest firm's unique resources and capabilities offer competitive advantage over rivals (Lanzolla & Markides, 2021). Moreover, sustaining resources as advantage, refers to dynamic capabilities which influence towards business model, is evitable (Teece, 2018). Dynamic capabilities' linkage to BMI is discussed in the chapter 2.3.

Overall, the strategic management view (e.g. Teece, 2010; Chesbrough, 2010) argues that strategic choices of positioning influence business model. The statement is further

supported by Kraus et al. (2020, p. 13) who argue that the trade-offs, managerial choices made based on firm strategy are vital part of BM's success and rise importance especially when boundary context changes (e.g., see Foss & Saebi, 2018). A result of the managerial choices are interdependencies in the selected BM that further influences competitive advantage (Amit & Zott, 2012, p. 46). Interdependencies highlight not only firm's value chain' but also the opportunities to adapt competitive advantage between stakeholders (2012, p. 46-47). Furthermore, it is safe to state that the dilemma between the two paradigms is not that BM is or is not firm strategy, but that unique source of competitive advantage follows positioning. Altogether BMs offer advantage by both resources and activity systems from both supply and demand sides (Lanzolla & Markides, 2021).

Regardless of whether BM constitutes strategy or serves as its outcome, outcome of the competitive advantage is reflected in performance. According to Porter (1991) competitive position leads to superior and sustainable financial performance. Similarly, Foss and Saebi (2017) state that outcome of changing business model ultimately leads to improved financial performance. Either by enhancing costs in focal firm's value chain or increasing customer's willingness to pay, a BM can create more value (Zott & Amit, 2007). Simply, the term competitive advantage indicates that firm has something better over its rivals that allows to excel for advantage that results in improved performance.

2.1.1 Business model elements

Regardless of which context business model serves, business models consist of parts for articulating the logic of value creation. Mapping different parts of business model allows to innovate to alternative solutions by communicating them (Chesbrough, 2010, p. 359). Different authors argue different amounts (Bigelow & Barney, 2021), and different approaches/perspectives (e.g., see Ritter & Lettl, 2018). Casadesus-Masanell and Ricart (2010) argue BM's parts divide between managerial choices of value chain and the consequences of the choices. A highly cited and references (Massa et al., 2017; Foss & Saebi, 2017) view of business model is the Business Model Canvas by Osterwalder and

Pigneur (2010) that consists of nine elements. The BM Canvas communicates the important capabilities and resources' alignment on the customer segments, and the BM's logic is described through the nine elements (Ritter & Lettl, 2018, p. 3). Especially, the core purpose of the BM paradigm is argued to be customer focus, that is about what is offered to whom and everything else evolves around this concept (e.g. see Osterwalder & Pigneur, 2010; Christensen, 2016; Wirtz & Daiser, 2018; Keiningham et al., 2020). Osterwalder and Pigneur suggest that identifying core customer segments allows to identify unique value proposition each one require.

Value: a core part of business model is the **customer value proposition** that solves an important problem or need for the targeted customer (Christensen, 2016). Sjödin et al. (2020, p. 161) argue in the modern view that value is created during customer's use of the solution, while in the traditional view value is created at the point of sale. Thirdly, in outcome-based BMs, value is co-creation of both the provider and customer (Sjödin et al., 2020, p. 161). Bowman and Ambrosini (2000) suggest that value divides between perceived use value and exchange value, and firms can gain competitive advantage by growing their difference, surplus value. Bowman and Ambrosini (2000) point out that the chosen offering gains monopoly at the moment of exchange since no other solution is able to offer similar surplus, net bundle of benefits. In its essence, value proposition creates competitive advantage over rivals (Osterwalder & Pigneur, 2010, p. 22). Moreover, behind value promise is distinct customer segment to which value is tailored for (Teece, 2010, p. 173, & 180). Perceived value is subjective (Bowman & Ambrosini, 2000), it can be categorized and dimensionalized by variety of variables (Osterwalder & Pigneur, 2010, p. 23-25). Osterwalder and Pigneur's definitions include that value can be function or performance related but also economic, reduce risk and uncertainty, or offer accessibility and convenience. In comparison, Porter's generic strategy differentiates competitive, firm's value positions into product differentiation, cost leadership and focus. Value is factor for competitive advantage since it addresses the customers need, problem, and foremostly, creates advantage by doing it better than alternative solutions. Therefore, value proposition illustrates the competitive advantage by its qualities.

Value creation is the action of creating the value promise. Müller et al. (2018) define value creating as tasks which firm performs in order provide the value promise. The tasks consist of activities the focal firm performs but also tasks performed by suppliers in the value chain (Müller et al., 2018). Therefore, value creation refers to the value creating resources, partners and activities of the firm's business model (Osterwalde & Pigneur, 2010). As mentioned in BM's contribution to competitive advantage, customer can also participate in value creation. That is especially, in the case of digital era, multi-sided platforms where customer data can be incentivized further (Massa et al., 2017).

Zott et al. (2011, p. 1031) state business models in the field of strategy conclude that one key area is networked value creation. Zott et al. (2011) state also the literature agrees business model is not just linear description of how value is created from supplier to customer but involves complex illustration between multiple partners. Altogether, contributing to competitive advantage by mirroring firm's interdependencies, efficiency and cost structure. Value creation contributes to competitive advantage especially by the managerial choices, how a value chain is set. Managerial choices not only highlight firm's network interdependencies, but the marginality of different value creation process, and especially the risk characteristics firm is exposed to.

Value Capture of BM includes that BM details revenue mechanism (Chesbrough, 2010, p. 355). Revenue stream divide into two grounding types: one-time transaction revenues and recurring revenues from ongoing delivery process or post-purchase support (Osterwalder & Pigneur, 2010, p. 30). Furthermore, revenue streams can be distinct to that of the value proposition and BM, and the pricing mechanism can also be divided between fixed and dynamic pricing (Osterwalder & Pigneur, 2010, p. 31-33). On the opposing side of revenue is the cost structure that demonstrates where and which parts of the BM create costs (Osterwalder & Pigneur, 2010, p. 41). Similarly, cost structure is tied to the value proposition and BM whether it is cost-driven or value-driven (Osterwalder & Pigneur, 2010, p. 41). In essence, value capture is how focal firm is compensated by

customers in sustainable way (Müller et al., 2018). Beyond focal firm value capture is distributing the profits among value chain and stakeholders such as providers, customer and partners (Sjödin et al., 2022, p. 161). Furthermore, value capture's relation to competitive advantage is important not only since value proposition, that value capture is part of by price, gains monopoly at the moment of exchange but because it demonstrates firm's strategic position. On the basis of firm operating, we know that firm's financial performance, that consist of revenue and costs, is indicator of competitive advantage.

2.1.2 EPC business model

The engineering, procurement and construction (EPC) business model consists of full-scale deliverable solutions as the main value proposition. EPC life cycle begins with feasibility studies, optimizing and procuring the supply chain. Detailed model and planning are made in the third stage, FEED study. Result of the three phases is final investment decision (FID), followed by an actual EPC project of construction and commissioning (COD) and finally, the operation of the solution (Andritz, 2025a; Karre, 2022). Core value creating resources of EPC-provider are the know-how engineering, technological and project management capabilities to provide the value promise (Schwartz, 2024), a working solution with certain expected level of results. Although, there are differences how the project is delivered regarding its management structure, size and type (Schwartz, 2024; Karre, 2022, p. 4-5). Foremostly, EPC contractor prevails majority of the construction project's risks depending how much customer wants to manage the project (Schwartz, 2024). EPC companies can specialize in set specific industry/sector or to variety of different sectors, and also by geographic focus (Karre, 2022). EPC-providers can also vary by competitive attributes, such as licensed technologies and construction labor forming the EPC firm's position in network. Additionally, source of income could be indicated for EPC provider's position, especially by focus on a specific part of project lifecycles. However, the renewable hydrogen industry is only forming and finished EPC projects and contract types remain abstract.

2.2 Environmental Regulation

Changes in the business environment and its conditions are recognized as a key igniting force for firms to adapt their competitive advantage among variety of scholars and fields in strategic management literature (e.g., Porter, 1991; Teece, 2010, p. 1; Barney & Bigelow, 2021; Teece, 2018, p. 43; Zott et al., 2011; Massa et al., 2017). In the second half of literature review, environmental regulation theory is reviewed to understand regulation's impact on competitiveness. Firstly, through these theories is to build theoretical basis how regulation moderates BMI and competitive advantage. Secondly, a review on the environmental regulation theories gives understanding on how the revised RED sets apart from other regulation. Finally, the section provides information for the theoretical framework.

2.2.1 Environmental regulation

Review of theory on environmental regulation is conducted to understand the revised RED, its RFNBO mandates and penalties' placement among different environmental policy instruments, and what these mean for competitive advantage in the emerging renewable hydrogen industry. Porter (1991) argues government and regulation act only as a starting force or catalyst in the boundary of national competitive advantage. However, regulatory change is inevitable to lift sustainable solutions to competitive position in order to overcome the climate change and decarbonization (Quarton & Samsatli, 2021). Environmental policies divide in many ways: grounding approaches come from energy economics, both micro- and macroeconomics where technological innovation is supported with economics approach (e.g., Shao et al., 2020). In essence, environmental regulation is about how policies promote sustainable technologies and solutions.

Grounding theories of environmental regulation competitiveness include the Pollution Heaven Hypothesis and the contradicting theory of that, the Porter hypothesis (PH). Porter and van der Linde (1995) argue that a well-designed environmental regulation leads to competitive advantage and profits exceeding the private cost caused by innovation, while beneficial social cost is achieved simultaneously. The pollution heaven hypothesis on the contrary argues that regulation poses higher private costs for firms and causes them to move into countries with relaxed environmental regulation (Dechezleprêtre & Sato, 2017, p. 183). Porter and van der Linde (1995) especially argue in the favor of dynamic theory of competitiveness since technology and customer needs are not static variables but they evolve over time. Furthermore, the Porter hypothesis divides into three versions of weak, narrow, and strong that vary by level of context, and each has varying support from academia (Fabrizi et al., 2024, p. 170).

While the two hypothesis mentioned prior argue on environmental regulations and economic competitiveness' relationship, the **compliance hypothesis** suggests firms follow regulation to avoid negative consequences (Wu, 2009). The two grounding compliance theories include the **green consumer** theory, and **the strategic behavior** theory (Wu, 2009). The strategic behavior theory argues that firms over-complying secure competitive advantage to future in order to be ready when regulation intensifies (Wu, 2009). However, I suggest that a third way to compliance is that firms comply and purposely avoid breaking the rules to avoid harm on reputation, and in the case of RED III compliance means avoiding penalties.

2.2.2 Regulation's effect and firm responses

Dechezleprêtre and Sato (2017) suggest environmental regulation affects firms in different ways varying by direct and reactive effects, in general firms' competitiveness measured by industry location, productivity, and trade. Specifically, policies affect relative production costs, to which firms respond with decisions on production (Dechezleprêtre & Sato, 2017). The first order effects impact relative production costs, while second-order

effect include responses by focal firms, and third order effects impact broader socioeconomic outcomes (Dechezleprêtre & Sato, 2017). Especially, price setting policies guarantee certain return against the costs but holds risk when demand is uncertain (Leisen et al., 2019). Dechezleprêtre and Sato's (2017) summary of different effects, from the first to third order are presented on **table 2**. In practice, regulation can therefore act both as a constraint and moderator of managerial choices in business models.

Table 2. Regulation effects on competitiveness (Dechezleprêtre & Sato, 2017).

First-order effect	Second-order	Third-order			
Cost impacts	Firm re-sponses	Economic Outcome	Technology outcome	International	Environmental
Changes to relative costs	Production volumes.	Profitability.	Product innovation	Trade flows	Pollution levels and intensity
	Productive prices.	Employment	Process innovation	Investment location	Pollution leakage
	Productive Investments.	Market Share	Input saving technologies	FDI	
	Investment in abatement.		Total factor productivity (TFP)		

Overall, government is recognized as a catalyst for firms to engage in sustainable innovation (Mazaheri et al., 2022). Governments can employ variety of mechanisms for promoting sustainable solutions. **Command-and-control** mechanisms such as penalties force firms to comply with regulations by law (Dechezleprêtre & Sato, 2017). While **market-based instruments** such as taxes, subsidies, emission trading schemes (ETS), and carbon border adjustments (CBA) provide economic incentives (Mazaheri et al., 2022; Fontagne & Schubert, 2023). A general way to categorize environmental regulation is promotion of new technology and solutions, and penalization of old, polluting technology

(Quarton & Samsatli, 2021). Quantity-driven incentives are known as Renewable Portfolio Standards (RPS) drive the market to purchase a quantity of specific resource and typically involve tradable certificates and penalties if not met (Quarton & Samsatli, 2021). The technology of renewable hydrogen production, electrolysis exists but achieving competitiveness requires policy support to reduce costs and create the market (Quarton & Samsatli, 2021).

2.3 Business model innovation

While business model demonstrates logic the customer, value proposal and value creating activities among others, business model innovation (BMI) demonstrates how changes to the business model itself are made in order to maintain competitive advantage. Chesbrough (2010) argues business model innovation demonstrates changes to the business model for bringing new ideas, value propositions to the market. Similarly, Sjödin et al. (2020) quote Foss and Saebi (2017) that BMI means changing the value creating, delivering and capturing parts of business model and/or the value creating architecture. Moreover, BMI targets one or more of the key components of BM (Foss & Saebi, 2017, p. 216). Specifically, the outcome of BMI can mediate change to existing parts of BM or result in novel parts to BM (Heikkilä et al., 2018, p. 109). Zott and Amit suggest (2012, p. 41) BMI maintains competitive advantage by introducing novel ways of doing the business with higher barrier of imitation than just establishing new product/service. Because competitive advantage is mediated through BM that basis on strategy, innovating BM becomes powerful way of sustaining competitive advantage.

Nonetheless, BMI's ultimate goal is to gain strategic advantage (Andrei et al., 2022, p. 1092), and to sustain competitive advantage (Zott et al., 2024, p. 28). The **strategic management view** (e.g. Teece, 2010; Chesbrough, 2010) suggests that the strategic goals define BMI (Heikkilä et al., 2018, p. 122). A central dilemma emerges over causality: does an innovated business model mediate competitive advantage directly, or is competitive advantage primarily strategy driven (e.g., see Foss & Saebi, 2017, p. 218)? Wirtz and

Daiser (2018, p. 22) highlight the often-referred statement from Teece (2010) that a new BM as the result of BMI can be a source competitive advantage when hard to imitate by rivals. However, critics argue that BMI is rarely an independent driver of advantage; instead, its impact is contingent on firm's underlying strategic orientation and resource base (Lanzolla & Markides, 2021; Teece, 2018). This tension highlights the interplay between strategy, resource configuration and BMI as a means of translating strategy into competitive outcomes.

However, pioneering new BMI does not always lead to competitive advantage, especially if a firm has high exit barriers on existing resources (Teece, 2018, p. 42). BMI carries high level of risk, highlighting the importance of managerial choices, tradeoffs regarding both the constitute that BM is, and strategy (Zhang et al., 2024, p. 122). On the other hand, BMI aims to sustain higher profitability than product, service or process innovation as mentioned. Lanzolla and Markides (2021, p. 543) suggest that unique business model innovation does not offer superior tool of advantage, especially in industries with high structural forces.

Overall, BMI's desired result, competitive advantage is indicated by improved financial performance (Foss & Saebi, 2017, p. 215 & 218). Firm performance is a way of measuring BMI's influence on competitive advantage since they are directly linked (Zhang et al., 2024; Latifi et al., 2021). Moreover, BMI and firm performance are also measured through **efficiency** growth, organizational **capabilities** and **revenue** growth which contribute to firm performance (Latifi et al., 2021, p. 3). Altogether these are consequences of BMI (Foss & Saebi, 2017, p. 218). The **table 3** clarifies different perspectives between scholars on the BMI paradigm and how BMI affects to competitive advantage.

Author (Year, page)	BMI definition	Competitive Advantage	Indication of Competitive Advantage (CA)
Mitchell and Coles, (2003)	Novel offering of product or services to customers; as well as novel value creating activities to make the novel offerings.	Deliver products and services in more profitable way than rivals.	Superior financial results, growth and shareholder value that are sustained over time.
Chesbrough (2010)	Purpose of changing BM to commercialize product/service innovations. BMI is changing the parts of BM.	(BM) "Formulates the competitive strategy by which the innovating firm will gain and hold advantage over rivals."	CA arises from organizational (managerial) capabilities that enable BMI. Maintaining the new BM is as vital as the BMI leading to it.
Amit and Zott (2012)	Adding novel activities; linking activities in novel ways, changing one or more party that perform activities (p. 45).	Staying ahead of competition. Product innovation to activity system (p. 42).	Novelty of change, lock-in, complementariness and efficiency. Improved profit margins.
Teece (2018, p. 45)	BMI is about adapting to the context, than just technological/product adaptation.	Arises from both the BM and firm's resources (i.e. dynamic capabilities)	Value surplus for both customer and firm.
Foss and Saebi (2017, p. 201)	"designed, novel, nontrivial changes to the key elements of firm's business model and/or the architecture linking these elements."	Firm performance.	Create and capture more value than competition.
Wirtz and Daiser (2018)	Changes to a BM, either evolutionary or radical. Based on Foss and Saebi (2017).	Satisfy customer needs better than competitors and continually.	Superior profitability, links to value creation and firm performance.
Müller et al. (2018).	Similar as Foss and Saebi (2017). Emphasize managerial input, and novel changes beyond firm's current BM.	Ability to leverage technological innovation for strategic leaderships, efficiency and value capture.	Outcome indication.
Latifi et al. (2021)	Refer to Foss and Saebi 2017. Changes to BM, 3 dimensions: value creation, delivery and capture.	Superior economic return via innovations hard to imitate.	Overall performance indicated either by efficiency, revenue growth and organizational capabilities.
Kraus et al. (2020)	How innovations are executed, introducing. Sustains long-term competitive advantage and introduces novel ways of doing business.	Execution to managerial problems.	Performance and survival in the market (p. 4).
Zhang et al. (2024)	Adopts Foss and Saebi (2017).	The achievement of superior firm-level outcomes (growth, profitability, market position) through BMI.	BMI based on production technology or on operating methods. Indicated by performance.

Table 3. BMI and competitive advantage definitions.

Business model innovation happens due to various reasons. Rabetino et al. (2025, p. 3) point that BMI begins from change either in the competition and companies' approach competition or change in firm's environment. Their perspective aligns from Foss and Saebi's (2017) framework that categorizes **external** or **internal** facilitators of change initiation. Similarly, BMI is essential for maintaining competitive advantage since technology evolves and competitors advance their products (Keiningham et al., 2020, 431; Teece, 2018, 41). Aagaard (2024, p. 5) states that BMI initiated by grand challenges and megatrends is integrated part of strategic core that is adopted by firms in the current landscape of BMI. Especially, the green transition means holistic and multifaced changes that requires managers to rethink their businesses as whole (Lüdeke-Freund et al., 2024, p. 127). However, Osterwalder and Pigneur (2010, p. 201) point out the apparent that BMs are formed in the firm's environment that consist of key trends, industry, market and macroeconomic forces. Together these are facilitators for firm's strategy since they set competition's narrative in the set industry (Osterwalder & Pigneur). In other words, these highly resemble Porter's (1991) dynamic perspectives on strategy. Additionally, BMI considers also the role of regulation both as moderator of change (Foss & Saebi, 2017), and igniting change (Foss & Saebi, 2017; Rabetino et al., 2025). Overall, BMI is driven by environmental shifts, competitive pressure, or both. However, these facilitators are interlinked – if a focal firm fails to adapt to its environment's changes, its competitors will, thereby intensifying competitive pressure. As a result, firm must engage in BMI just for the sake of maintaining competitive advantage.

Business model innovation process. Heikkilä et al. (2018) suggest BMI process is simply aligning with the reasoning on what BMI is, (i.e. changing parts of BM or the architecture of BM). Sjödin et al. (2020) argue the process of BMI begins with defining the value promise, followed by value provision design and finally, value-in-use delivery. Amit and Zott (2012) argue three ways for BMI to occur include either by adding novel activities through forward or backward integration, by linking activities, or by changing one or

more parties performing the activities. Protecting the imitability of these changes, successful BMI requires strategic analysis and understanding of firm's competitive position (Teece, 2010, p. 180; Porter, 2008). In summary, scholars give different definitions of BMI process ranging from incremental changes to comprehensive architectural configurations.

Zhang et al. (2024) suggest that BMI can be measured with variety of variables and scopes depending on the characteristics of change. Foss and Saebi (2017) present that BMI concept extents to how novel the changes are, and the scope of the change in **figure 2**. Novelty differs by the level of innovation, new to the firm or industry (Foss & Saebi, 2017). While **scope** of BMI refers to the architectural part of BMs, which parts and how business model is changed. However, Zhang et al. (2024) point out other vectors such as the sources of value creation, innovation's scope between closed and open, market perception and finally, source of competitive advantage. Regarding the earlier statements on competitive, external pressure, when focal firm's BM is innovated, it is simply BMI. According to Geissdoerfer et al. (2018, p. 405-407), the typologies also illustrate that BMI can steam from explicit strategic antecedents: a start-up's initial design of BM, or a merger and acquisition forcing a reconfiguration and integration of BM architecture. This highlights that BMI can emerge from high-level, strategic decisions. Therefore, when change is only impacting the focal firm but remains new to industry, firm strategy is impacted. In contrast, where stakeholders are impacted, change becomes ecosystem level change. Finally, competition level change is when BMI forces rival to adapt their own business models. In summary, the synthesis on strategic measure of BMI is presented in **figure 3**.

Novelty	Scope	
	Modular	Architectural
New to firm	Evolutionary BMI	Adaptive BMI
New to industry	Focused BMI	Complex BMI

Figure 2. Measurements of BMI (Foss & Saebi, 2017).

Antecedents	Level of external change		
		Macro-level	Micro-level
	External	Ecosystem	Competition
	Internal	Strategy	BMI

Figure 3. Strategic measuring of BMI (author's inducement).

Organizational, **dynamic capabilities** offer alternative way of examining the BMI process, that is for maintaining competitive advantage. Dynamic capabilities have been an emerging theme in the BMI literature (Zhang et al., 2024); they represent internal drivers for innovating both a firm's competitive advantage and business models (Oliveira-Dias et al., 2020). Conceptually, Teece (2018) suggest a firm's current BM demonstrates **base-level** capabilities by which firm in engages in its current operation. In a contrast, dynamic capabilities allow firms to sense and response to changes, sustaining competitive advantage (Teece, 2018). These are further divided to micro foundations of adapting the base level capabilities, and then to the dynamic capabilities itself that sense avenues for the future (Teece, 2018). The dynamic capabilities are further dividend by which part of BMI process is engaged between sensing, seizing and transforming (Pieroni et al., 2019), that offer model of innovation process in BMI. Overall, BMI relies on organizational capabilities, dynamic capabilities in order to leverage existing resources or create new ones to sustain competitive advantage.

Overall, Foss and Saebi (2017, p. 215) present research model of BMI that depicts external and internal factors initiating BMI that is influenced by different level moderators, ultimately leading to outcomes in performance, innovation or cost reduction. **Figure 4** illustrates these. However, Zhang et al. (2024) argue that the outcomes are additionally mediates by the same variable, and there is industry-level performance in addition to firm-level.

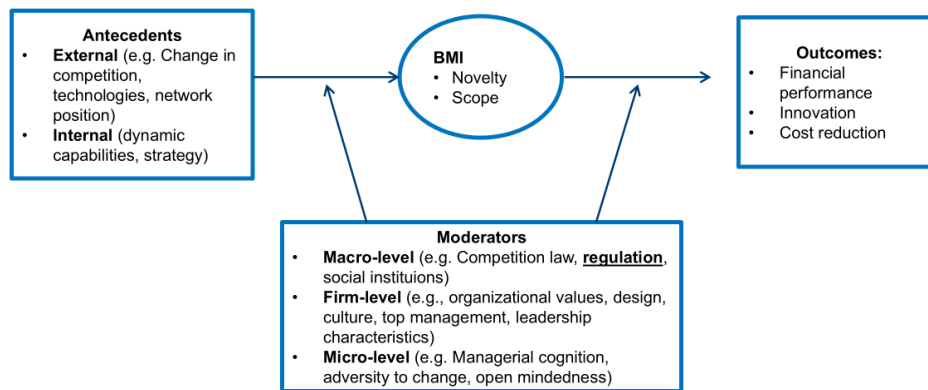


Figure 4. BMI research model (Foss & Saebi, 2017).

2.4 Theoretical framework – synthesis

This chapter presents the business model and innovation theories with environmental regulation into the theoretical framework. The framework aims for holistic view BMI's influence towards firm-level competitive advantage and how the process is moderated by environmental regulation. Foremost, firm strategy is a key factor on business model that is subject to innovation. Innovation of either one, strategy or BM begins from the antecedents that are either external or internal of firm. BMI is measured by novelty and scope of the change contributing to sustaining competitive advantage. However, while BMI goal contributes to the competitive advantage, the outcome of BMI is measured by performance. Above all, the framework articulates the main research question, how can firms sustain competitive advantage by understanding environmental regulation in the renewable hydrogen industry? The framework is presented in the **figure 5**.

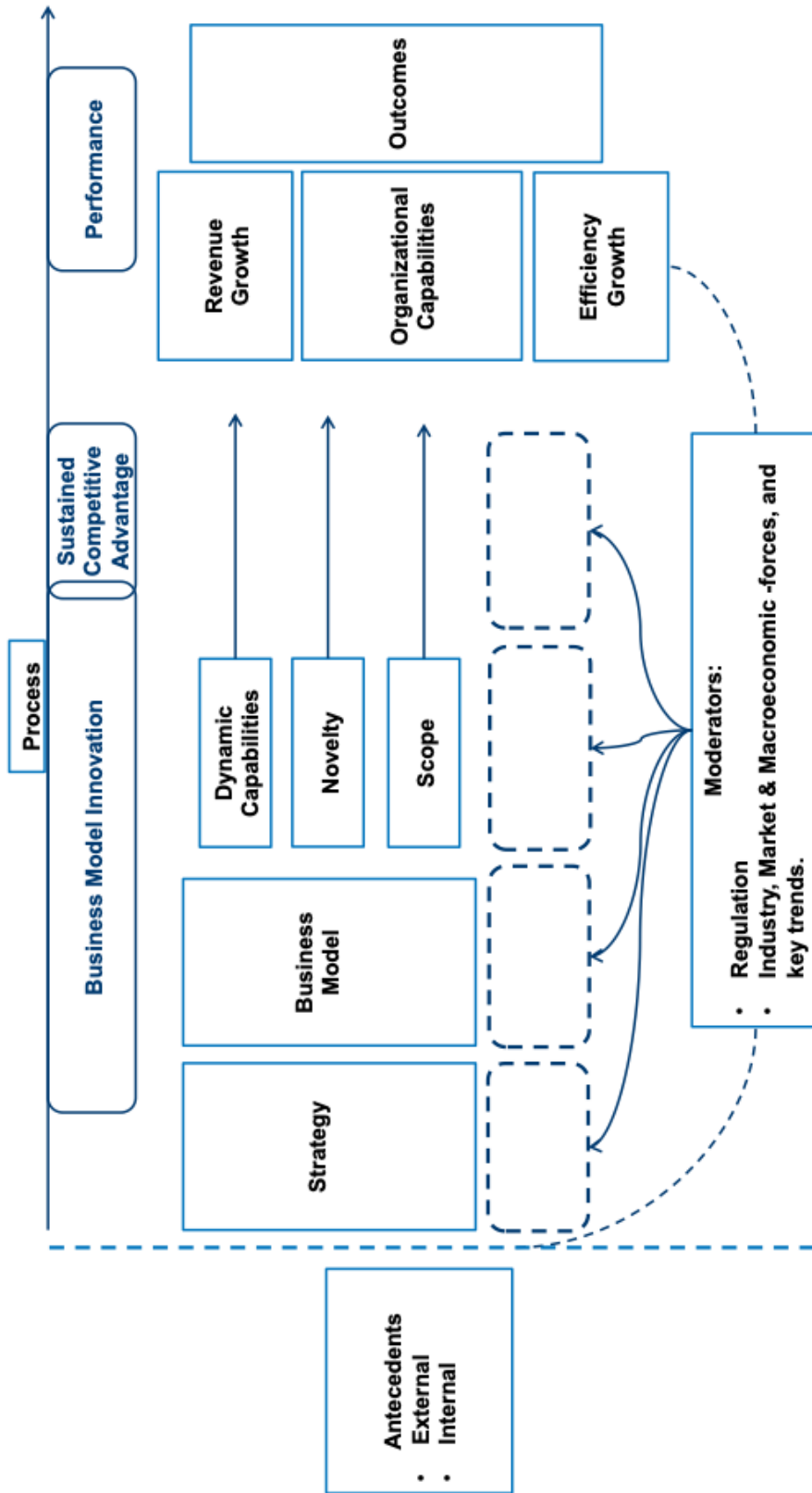


Figure 5. Theoretical framework.

3 Methodology

Methodology chapter presents the research methodology used to carry out the results for the question and objectives. The research design formulates how researcher intends to find the solution to their research question and objectives (Saunders et al., 2023, p. 19). The method of empirical study is described by philosophical assumptions, research strategy and method. These describe how theoretical results are formed together with the description of data collection, sampling and analysis. Finally, the chosen method's potential limitations are recognized. Overall, the Research Onion is conceptualization illustrating the research process as depicted, explaining how the results are built (Saunders et al., 2023). The **figure 6** showcases the choices for the study's research approach.

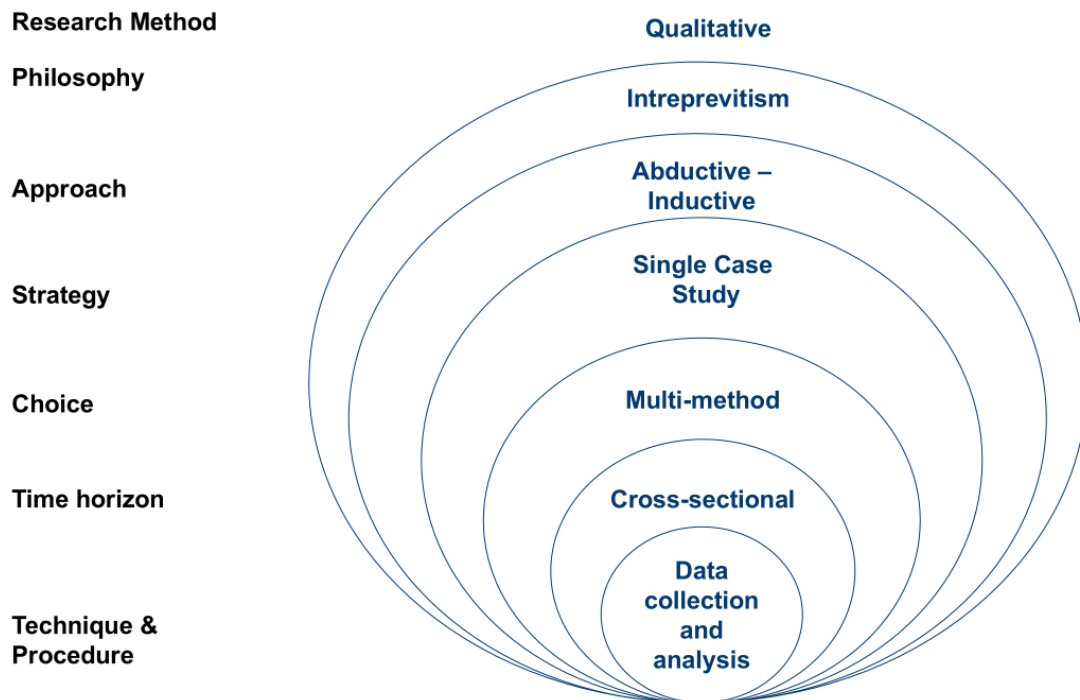


Figure 6. Research onion (adapted from Saunders et al., 2023).

3.1 Philosophical assumptions

Research philosophy is not only for justifying the chosen method, strategy and approach for the thesis (Saunders et al., 2023, p. 128), but it defines the underlying approach on

how and why results are conducted the way they are (p. 131). According to Saunders et al. (2023) interpretivism as research philosophy emphasizes understanding social phenomena through how individuals assign them. Realization of the research philosophy is the **research paradigm** (Saunders et al., 2023, p. 135) that is the lens on how results are interpreted.

This thesis applies variation between inductive and abductive research approaches on theory development since common theories are used to describe patterns and themes related to the case and design process, but novel theory is developed from the collected data (Rashid et al., 2019). As novel phenomena are studied, the study applies inductive nuances (Saunders, p. 155). It is recognized that interests between academic research and practical managerial problems do not necessarily meet (Holmström et al., 2009). The thesis goal and results contribute both theoretically with the empirical study and practically with the strategic insights for the employer company. Specifically, the research strategy constitutes case study that allows to study problems in the real-world environment and create novel solutions but also contributes to the academic literature.

The time horizon is cross sectional with prospective focus. The data was collected within set time during the Spring 2025, while the analysis emphasizes the future implications.

3.2 Research method

A study with novel contributions requires collecting and sampling of data to test its question of research, whether qualitative or quantitative. Saunders et al. (2023, p. 181) state quantitative study utilizes usually numerical data, for testing a hypothesis. A key character for quantitative study is that similar results can be achieved by independent researchers conducting study with same parameters. In contrary, qualitative study utilizes sources such as interviews and pictures that form non-numeric data, making it dependent on the researcher (Saunders et al., p. 181-184). Qualitative study can use either primary or secondary data, where researcher collects the primary data themselves, and

secondary data bases on existing sources collected by others (Saunders et al., 2023). Moreover, when qualitative study utilizes more than one source, it forms multi-method qualitative study (Saunders et al., 2023).

This thesis utilizes multi-method qualitative by utilizing both primary and secondary data. Semi-structured interviews with case industry professionals form the primary data. The secondary data collection consists of a variety of methods from white papers and industry analysis, studies, both public webinars and direct interviews with industry experts. The secondary interview's purpose is collecting information regarding the industry, and regulation in general in order to gain understanding of the phenomena's context, fulfill missing gaps from the primary data for the case topic's holistic character.

3.3 Research strategy

Research strategy is the connection between research philosophy and the chosen method for data collection and analysis, meaning the plan for executing the study including data collection (Saunders et al., 2023). Following qualitative research, the thesis adopts a holistic approach in a single case study within the renewable hydrogen industry in the European Union, hydrogen regulation, specifically the Renewable Energy Directive.

Case study as a research strategy allows to conduct qualitative research on real-life phenomenon that leads to rich empirical contributions to theory development (Saunders et al., 2023, p. 206). Case study allows to explore complex research problem in set context and especially allows to utilize different types of data such as both qualitative and quantitative (Eriksson & Kovalainen, 2016). Overall, according to Eriksson and Kovalainen (2016, p. 131) case study allows to understand the logic of the case rather than generating causal explanation.

3.4 Case and data

The case and data chapter explains the background context of the case. Although, a holistic in-depth analysis is provided in the value system analysis. Foremost, this sub-chapter presents the data collection and analysis on the 12 semi-structured interviews as well as secondary data.

3.4.1 Case industry and company

The renewable hydrogen and e-Fuels industry is a prominent pathway for sustainable energy transition and mitigating the grand challenge of climate change. Renewable fuels and hydrogen present a new industry globally since they require innovation and commercial ramp-up of novel technological solution (Migliavacca et al., 2024). Its commercial viability and ramp-up relies on cross-sectoral collaboration presenting unique case opportunity where each part of the hydrogen/e-Fuel value chain is influenced by regulation. The nominal regulation case is the European Union's, that is the European Parliament and Council's (EU) Renewable Energy Directive 2023/2413, namely 'RED III' that introduces mandates for the use of Renewable Fuels of Non-Biological Origin (RFNBOs), that are based on renewable hydrogen. The directive mandates that by 2030, at least 42% of hydrogen used in industry must be renewable, and 1% of all national energy use in transport must come from RFNBOs (EU, 2023/2414, article 25). However, the member states of the European Union, have relatively large freedom to define their legislation based on the directive. This study focuses on implications for e-methanol in the context of maritime sector as the down-stream end-use sector.

The case company of this study, Andritz AG is Austrian technology and engineering company, and case especially focuses on its P2X business unit. The company has over 30,000 employees and operates in over 280 locations in 80 countries (Andritz, 2025c, p. 26). The company's four main divisions are Pulp & Paper, Metals, Hydropower, and Environment & Energy, last of which includes the P2X business. Andritz's 2024 revenue was **8,313**

million euros, with EBITDA of **887** million euros at **10.7%** margin (Andritz, 2025c). Of that, the Environment and Energy had **18%** of total revenue at **1,503** million euros with EBITDA of **198** million euros at **13,2%** margin. At the core of the P2X strategy are the know-how in carbon capture technology, renewable hydrogen production, and the e-methanol synthesis (Andritz, 2025c, p. 32-35), with robust EPC experience. Based on Andritz's (2025d) internal public relations communication material, Andritz P2X's value proposition for the e-Fuel business is specific: "provide solutions for the production of renewable hydrogen, e-methanol and e-ammonia. Andritz's services range from early engineering consulting to EPC-project execution and full life-cycle services."

3.4.2 Data collection

Detailed explanation of measures used for data collection enhances study's credibility and reliability (Zhang & Shaw, 2012, p. 9-10). Interviews are used to learn and study novel phenomena since they provide valid and trustworthy information regarding the topic (Saunders et al., 2023). Eisenhardt and Graebner (2007, p. 38) state diverse interviewee sample group enhances study's credibility by limiting bias. Meaning, interviewees variation by such as geographic location, hierarchical position, value system positions enrich the data quality (Eisenhardt & Graebner, 2007).

Each study requires identification of population for samples, out of which forms the target population and finally, the sample (Saunders et al., 2023, p. 291-292). The initial target population was recognized from the RFNBO value chain (**Figure 8** in chapter 4.1.2). The target population was identified with variety of sources from the case company's account and stakeholder network, the Finnish Government's consultation documents to legislative bill preparation, industry related reports, LinkedIn search and exploration, interviewees in newspaper articles, different types of lobby groups, and personal recommendations from interviewees. Potential interviewees were inquired directly about willingness to participate via the various different channels. Trust is essential factor when approaching potential interviewees, and especially when cold approaching (Saunders et

al., 2023, p. 237). A guiding document in **appendix 1** was provided to clarify how interviewees' answers would be used in the thesis in order to create trust towards recording and anonymity. Additionally, phone calls with the 3rd party interviewees helped in accessing the interviews especially, without any prior connection.

The interviewees are listed in the **appendix 2** by the chronological order from the first interview. Specific details are limited to generalized position, years of relevant experience and the interview length in minutes and hours, in order to distinct interviewees yet remain anonymity. The sample is cross-sectoral with professionals consisting of the EPC case company, consultants, energy industry, infrastructure, oil and gas, maritime, project developers, altogether 7 sectors. Interviewees' geographic focuses vary between solely Finland, European level and global scale but is not further specified to remain anonymity. Foremostly, all have experience with hydrogen regulation in the European Union, renewable hydrogen business and industry. Relevant experience is considered from other sectors since the renewable hydrogen industry is only emerging. Policy makers, such as elected officials or ministries were not interviewed for primary data, but the secondary data 3, 9 and 10 included speakers in policy making, including a Finnish legislator, A Dutch government official, and multiple policy makers at the European Union's governing bodies. Additionally, some of primary data's interviewees have lobbying experience.

The semi-structured interviews length from 50 minutes to almost two hours. A total of 12 interviews with 11 interviewees were conducted, the first on March 20th of 2025, but the rest between May 13th and June 18th. 10 interviews were conducted via Microsoft Teams and two face-to-face. The second-round interviews were conducted with two interviewees, two (2) and six (6). Recordings were made with the exception of interviewee 2 who did not want to but gave permission to make notes and therefore interviews were summarized right after. List of questions was delivered to each interviewee before which set the general conversation structure and provided further information regarding the topic. Three interviews were conducted in English and nine in Finnish.

A general structure of the interview questions is presented in the **appendix 3**. The questions divide into three general categories from general introduction, identifying regulation and thirdly, discussing the Andritz's position in the case industry. Individual questions were included for each interviewee's distinct sector by their industry and position in their organization. Along the questionnaire, figures including the RFNBO value system (**figure 9**) and theoretical framework (figure 5) were provided. Semi-structured interviews' goal was to have open discussion around the topic than strict conversation in order to get richer insights (Eriksson & Kovalainen, 2016, p. 94). Specifying questions could be made during the interviews. The author's personal interviewing skills adapted throughout the interviewing process by interviewing techniques such as active questioning. Meaning that recognizing key points such as if an interviewee mentions a difficulty, they would be asked to explain those in more detail.

Secondary data was collected throughout the thesis process. The multiple sources consist of strategy workshops, interviews, webinars and industry reports and papers. The secondary data collection was both structured and not structured. Detail of the secondary data with details on type, source is presented in the **appendix 4**. Primarily, the secondary data contributes by providing additional perspectives such as policy making as mentioned earlier, and others that the author could have missed. Systematic analysis of collected data is important and vital for not missing relevant perspectives (Yin, 1994), and therefore, systematic collection of the data is as important. The secondary sources 1 to 4, were summarized into executive summaries. This rather practical way of summarizing data only considers 'important', novel and significant information at the moment of discussion/interview, compared to full recording transcripts. On the other hand, the summaries were made right after the set meetings from memory and notes on keywords and statements. Additionally, sources 3 and 4, public webinars shared presentation material with audience. The author was involved in actual strategy work in the secondary source 5.

3.4.3 Data analysis

Data analysis should result in a solution for the study's problem where a successive solution is result of successive system in the analysis (Yin, 1994). Successive analytics consists of foremostly, general analytics strategy and secondly, specific techniques (1994, p. 105-106). This includes author describes precisely how they collected the data for their study and the methods and techniques they use for analyzing and making conclusions out of that (Saunders et al., 2023; Gioia, 2021). As mentioned, recordings and transcripts were made with exception of one interviewee. Specifically, transcripts were generated with Microsoft Stream from Microsoft Teams recordings, then composed and corrected into full texts from errors with review of the video recordings. Additionally, specific statements were reviewed from recordings on how the interviewees reacted with expressions and change in tone, and the interviewees reactions were written into the transcript. For the example, “*reaction description*” after a comment. In total, 172 pages of transcripts were made across the 10 recorded interviews.

Following transcript composing, the next step is coding the raw data into usable data to test study's hypothesis (Saunders et al., p. 665), that is the research question in the case of qualitative study. Data coding means categorizing the answers with similar meanings (Saunders et al., p. 665). Initial concepts recognition is the first step of the grounded/Gioia method, and the goal is to induce the concepts from the interviewees' answers than use theory as base (Gioia, 2021, p. 24-25; Saunders et al., 2023, p. 684). The initial answers are compared and then induced into the first-order concepts which focus is similar as thematic coding but based purely on the gathered data (Saunders et al., 2023). Initial concepts coding began during the interviews by making notes of key words and during transcript composing. A throughout coding was done in Microsoft Excel to purely base the analysis on the collected data and follow the grounded method (Gioia, 2021). Each interviewee and the coding were placed row by row in the column A in a chronological order in order to induce codes and key words from transcripts, with a review of recordings when needed. The rest of the columns followed with quote of the comment for each code row. To capture emerging themes and synonymous variations, one or more induced

codes were added below a grounded code. By stacking them under the grounded code, a clear visual linkage was maintained between core concept and nuanced variation, helping manual analysis among the vast amount of grounded data. Over 150 1st order-order codes and categories were listed in total between the interviewees in the Excel.

The grounded codes are compared between and then induced into the first-order categories that hold similar meaning (Nag et al., 2007, p. 828). The first-order categories are followed by second order themes that group the specific categories into abstract themes (Saunders et al., 2023, p. 667). Data comparison of grounded codes between different interviewees was conducted via matrix comparison of a common code and interviewees, by marking with X for each interviewee that had the code emerge in their interview. Matrix example provided in **appendix 5**. The matrix process helped formulating second-order themes and inducement of the aggregated dimensions. The result of the analysis, data structure is presented in the **figure 7**.

Finally, presenting the results in a coherent logic follows the theoretical framework. In order to actually argue and justify the findings, different analytics techniques are utilized. Firstly, Grodal et al. (2021, p. 604) suggest the importance of data structure for presenting findings between the 1st order categories to aggregated dimension, and theoretical framework. Data structure allows the developing empirical rigor, and further on the novel contributions to theory (Gioia, 2021; Grodal et al., 2021). Furthermore, for a testing hypothesis, explanation building is relevant technique consisting of initial assumption and revising that by comparing with the findings (Yin, 1994, p. 114). Especial, careful analysis between overall unit and embedded units is a key concern regarding case study in order to avoid biased findings (Yin, 1994).

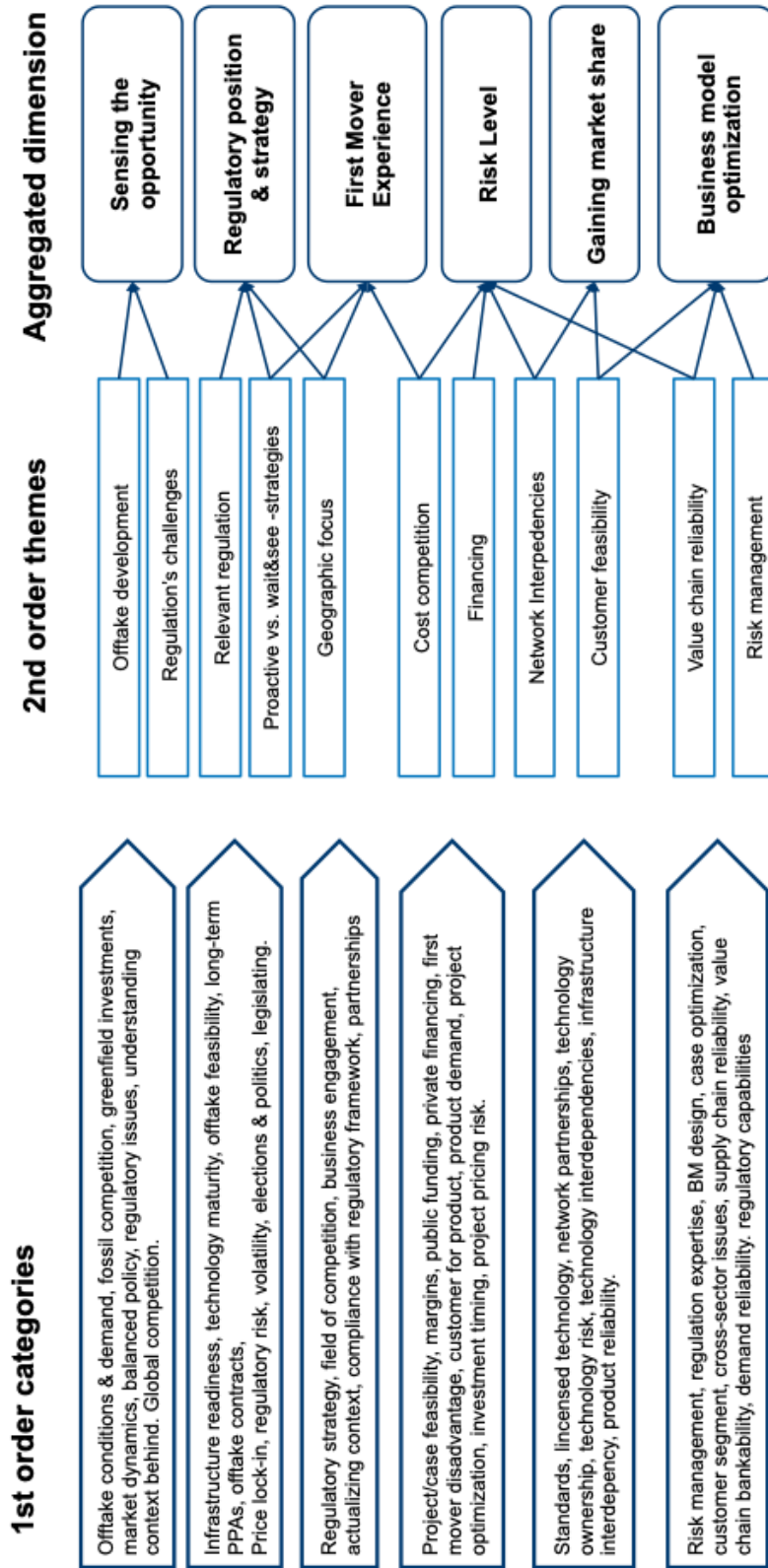


Figure 7. Data structure.

3.5 Validity and reliability

In order to assess the quality of a study, it is essential to evaluate validity and reliability (Saunders et al., 2023, Eriksson & Kovalainen, 2016). Rigor in a case study context guides the assessment of accuracy and credibility of the conclusions, findings and the contribution to theory (Gibbert et al., 2008).

First, according to Gibbert et al. (2008) a case study can address validity through multiple strategies, including triangulation, theoretical framework, and transparent research design. Especially, the study's theoretical framework provides two comparison vectors for assessing validity: first, it explicitly defines the author's approach on the topic and knowledge of phenomena, theory. Second, it provides framework to compare the study's results to existing literature and validate them. The holistic nature of the study poses question of validity. Especially, Yin (1994, p. 120) suggest that embedded unit of analysis requires careful attention on not generalizing results from embedded unit with overall results without cross analysis or use of different techniques. These concerns are addressed through triangulation or primary interview data and secondary material, as well as explicit documentation of the analytics, enhancing both construct and internal validity.

Secondly, reliability refers to the consistency of the data, whether the results can be repeated under similar conditions (Eriksson & Kovalainen, 2016, p. 304). The chosen strategy, case study of regulation for industry, and the analysis method, grounded/Gioia ensures systematic collection of treatment of the data. The **figure 8** presents the study's research process and steps, which enhance transparency on the result's reliability and construct validity (Gibbert et al., 2008, p. 1467). Along that, the philosophical assumptions are also mentioned in previous chapter, that is why results are interpreted the way they are (Saunders et al., 2023).

Practical limitations raised during execution of the research regarding the timeline and thus research strategy. Firstly, the study's scope was revised regarding research question and objectives from the original that was to understand how the different European Union member-states position themselves from the RED-directive. The thesis project begun in 7th of January 2025 but the scope was revised in 19th of March limiting the study's time to three and half months. Additionally, although the first interview was conducted nearly two months before the rest of the interviews, the topic, case's regulation remained the same unit of observation, The RED III directive. Moreover, the grounded method allows data collection right from the start of the research idea (Saunders et al., 2023, p. 202).

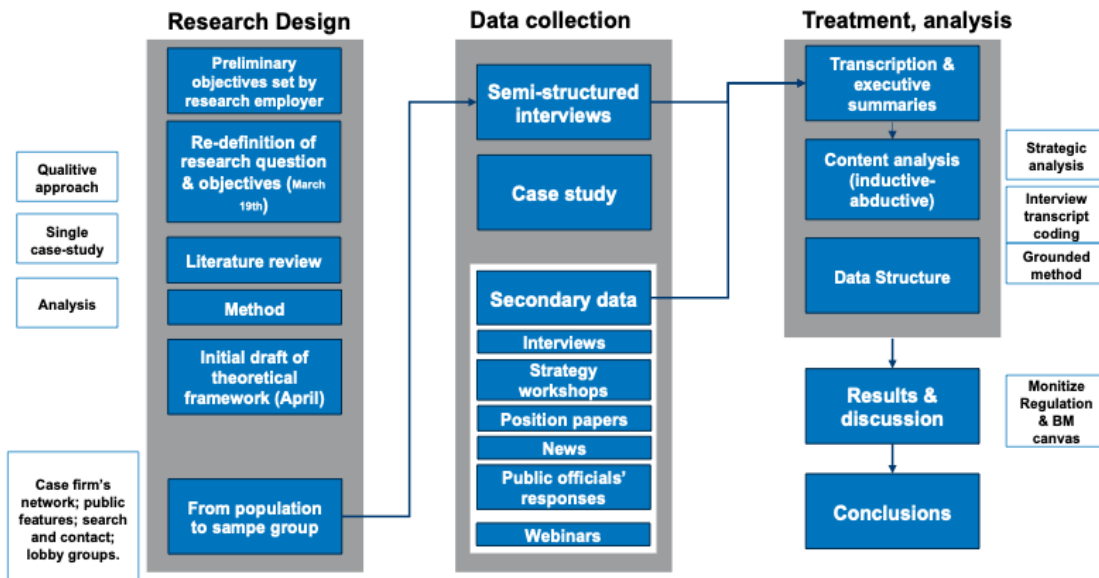


Figure 8. Research steps (adapted from Oliveira-Dias et al., 2022, p. 115).

4 Findings

The findings chapter reveals the found results of the study. The results are linked to the theoretical framework (figure 4) in order to answer the research question and find solution for the research problem (Saunders et al., 2023). The findings begin with practical context analysis discussing strategic setting of the case industry in chapter 4.1. The first empirical section, chapter 4.2 analyses regulation's relevance for the case industry by summarizing regulation as antecedent of change and challenges. The chapter 4.3 follows with cross-analysis between the business process and regulation as mediator from the theoretical framework. The process steps include firm's strategy and primarily, business model innovation towards competitive advantage. Finally, the results are summarized and the revised theoretical framework presented. Overall, answering how environmental regulation impacts strategy and competitive advantage.

4.1 Context

The context chapter presents the results of strategic analysis on the case industry, providing in-depth understanding of the regulation and RFNBO, specifically E-Methanol industry's value chain analysis. A key observation regarding unit of analysis, the interviewee's as well as secondary data, discuss of business models especially in project-level business than holistic value creation.

A renewable hydrogen production project has similar investment characteristics as any other energy industry project: high capital expenditure (CAPEX), long investment time, stakeholder's participation. The renewable hydrogen industry attracts newcomers regardless of their size due to its emerging nature. Power to solution (P2X) project developers have been fore runners in industry long before regulatory mandates, while incumbent industries are looking to transition from fossils to renewables. The renewable hydrogen and the RFNBO markets are only emerging. The current use of hydrogen (99%) limits mostly to refining and chemicals which are not at significant position for climate

change mitigation (Pingkuo & Junqing, 2024). Hydrogen usage amounts only for 0,1% in industries contributing to climate change. However, the potential sectors such as transportation in climate change mitigation offer major opportunity for renewable hydrogen (Pingkuo & Junqing, 2024). Hydrogen Europe's 2024 status report (Espitalier-Noel et al., 2024 p. 20) points that the European Commission's goal of 10 Mt domestic production requires installation of 100 GW electrolyzers compared to 40 GW goal set in the *REPowerEU* plan by the Commission. The 100 GW installation goal requires a growth rate of +153% annually to meet the 2030 goals in Europe but the actual CAGR has been only +44% since 2020 (Hydrogen Europe, 2024). The hydrogen uptake is more challenging than estimated earlier due to limited growth of renewable energy sources and cost competitiveness that includes cost of renewable electricity and price of electricity; cost of RFNBOs in the current context; and the cost of technologies deployed (Sochor, 2025, p. 11; Motola et al., 2023, p. 46). Renewable hydrogen's cost is two-three times higher than blue, carbon captured hydrogen's (Pingkuo & Junqing, 2024). The cost is driven mostly by renewable electricity's marginal cost and the capital cost of electrolyser (Pingkuo & Junqing, 2024; European Court of Auditors, 2024). Total installed cost will decrease over time by growing number of investments. In total, there are number of factors affecting renewable hydrogen production profitability in practical sense (Deloitte, 2024a: 13; Andritz, 2025a, p. 4). Both macro- and energy economy factors such electricity supply, and project success factors such as subsidies, offtake certainty and market development.

4.1.1 RFNBO regulation

The following section describes and analyses the relevant case regulation, providing the reader a comprehensive understanding of the regulatory context. The revised **Renewable Energy Directive** (RED) (EU, 2023/2413) gives a legal **definition** for renewable hydrogen, an updated version of the prior directive (EU) 2018/2001. The RED III redefines the meaning of the Renewable Fuels of Non-Biological Origin to all uses, while the RED II considers the use as a transport fuel only (EC, 2024b). The revision defines RFBNO: *"renewable fuels of non-biological origin' means liquid and gaseous fuels the energy*

content of which is derived from renewable sources other than biomass» (EU, 2023/2413, article 2, 36). Therefore, RFNBOs exclude biofuels since they derive energy content from biomass. According to the European Commission's Joint Research Centre (Motola et al., 2023, P. 9), RFNBOs divide between electrofuels (e-Fuels), Power-to-Gas (PtG) and Power-to-Liquid (PtL). Foremost, The RED establishes the grounding definitions of RFNBOs, such as supply chain traceability and GHG emission reduction rate. The European Commission has published two Delegated Acts to define the RFNBOs in detail (Migliavacca et al., 2024, p. 4) as of Spring 2025. Although the RED provides the foundational framework, other key acts and delegations include the Hydrogen and decarbonized gas market package, Methane Regulation, Carbon Removals and Carbon Farming Regulation (Deloitte, 2024, p. 13). As well as Tholen et al. (2021) point out that EU-level policy instruments such as substitutes play a vital part in making the green hydrogen economy alive at a local member state level.

Above all, RFNBOs are hydrogen derived fuels such as hydrogen itself, e-methanol or e-ammonia (EC, 2024b). Hydrogen itself is energy carrier that can be used to produce downstream products as mentioned above, and a decarbonized gas (Dolci et al., 2022, p. 6). In general context, the hydrogen downstream can be divided to feedstock meaning feeding industrial processes, and to energy vector meaning the fuel solutions (Migliavacca et al., 2024, p. 1). Renewability is a key aspect of the RFNBOs since the new fuel solutions cannot be considered renewable unless their production's value chain is 'renewable'. The revised RED sets defining elements for RFNBOs, while the EC's delegated regulations (delegated acts) define the criteria specifically. The EU's RED II directive (2018/2009) defines '*renewable sources*' as by the source type meaning non-fossil fuels such as wind, solar energy, and geothermal, and other energy sources existing in the nature. These sources consist mostly of primary sources existing in the nature. Defining element of the RFNBOs is that they meet 70% reduction in greenhouse gas emissions to their relevant fossil competitor. Moreover, renewable electricity to produce RFNBOs is defined specifically in the European Commission's delegated act 2023/1184. The four

primary methods include Power Purchase Agreements (PPAs), direct source, geographical correlation and variation between.

Electrofuels (e-Fuels) are often mentioned with RFNBOs but refer to a broader term for fuels made using electrolyser to produce hydrogen (H₂) (Nemmour et al., 2023, p. 29014). e-Fuels as synthetic fuels are meant to replace conventional fuels such as fossil kerosene, and foremostly allow the replacement of these conventional fuels without changing the combustion engine technology (Nemmour et al., 2023). RFNBOs, other than hydrogen solely require additional feedstocks, such as carbon dioxide or nitrogen depending on the fuel. Specifically, e-methanol is produced synthesizing hydrogen together with carbon dioxide (CO₂) where the used renewable H₂ is derived with electrolysis, and the CO₂ is captured, usually from renewable source (Nemmour et al., 2023). CO₂ can be sources from biogas, biomass, captured industrial flue gas as by-product or directly air capture (Nemmour et al., 2023, p. 29017). However, the 70% GHG emission reduction rule becomes relevant in the CO₂'s source as well as for electricity. Water electrolysis is the dominant method of producing renewable hydrogen (Dolci et al., 2022, p. 10), by applying electricity as an energy carrier to separate oxygen and hydrogen from water molecule. The three common methods of water electrolysis include alkaline electrolysis (AEL), proton exchange membrane (PEM) and solid oxide electrolyser (SOE) (Dolci et al., 2022, p. 10). In practice, Dolci et al. (2022, p. 10) state that AEL is stable and cost-efficient technology that does not rely on rare metals, while PEM offers better flexibility and responsiveness but depends on rare metals and expensive catalysts. According to Dolci et al. (2022, p. 11) AEL and PEM have achieved commercial maturity stage, and AEL promises the best CAPEX at the largest megawatt (MW) quantities (Andritz, 2025a). For context, according to the European Court of Auditors (2024, p. 10) cost of renewable hydrogen varies between \$3.6-12.0/kg, compared to \$1-3/kg of gray hydrogen using natural gas.

Shortly, the key differences in governing of legal acts between the European Commission and member states. Implementation of both directives and regulations into national law

is left to the member states themselves. Key distinction is that regulation must be applied precisely to what the commission demands, while member states have freedom to adapt laws to match their local conditions meeting the minimum requirements in the European Union's directives. Each member state has their distinct ministry(ies) with distinct national agency of creating and implementing the law from the directive. The governing roles play vital role how legal acts are implemented at different levels. Foremost, member states have obligation to report progression of goals to the commission. (secondary data 5).

The key regulating instruments of the revised RED include minimum mandates of renewable fuels for suppliers and potential penalties if not compliant to supply the minimum amount. RFNBOs have separate mandate figures for both industry and transportation sectors. The revised directive aims to drive fuel suppliers to invest into new technologies with instruments such as the mandates and penalties, that will vary by member state. However, the current electrolysis technology investments are expensive, and the operational costs are heavily influenced by availability of resources, such as renewable electricity and carbon dioxide. Specifically, the articles 22 for industry, and 25 for transport industry are quantity driving incentives, since these mandate, command-and-control towards fuel suppliers to supply RFNBOs. However, the RED does not mandate setting penalties but leaves it to the European Union and member states posing potential risk for market ramp-up (Hydrogen Europe, 2025). The obligatory mandates together with the demand driving initiatives (e.g., FuelEU Maritime & REFuelEU Aviation) form a market-mechanism since they oblige member states to set obligatory mandates of RFNBOs share in total energy consumption, creating a market for RFNBOs. The directive and the initiatives are therefore a mixture of market mechanism and command-and-control, and foremostly the quantity element makes them an RPS. On comparison between RED II and III, the RED II's objectives are energy-based but member states are free to adopt them to local conditions which has led to various distinct systems between nations (Sipilä et al., 2023, p. 19). The energy-based system is the most common among member-states, while volume-based systems in few, and only Germany and Sweden have GHG-based

(Sipilä et al., 2023, p. 20). The revised directive changed the energy-based obligations to GHG-based, although it is not mandating to change for member states (Sipilä et al., 2023, p. 30). Secondly, and foremostly, the revised directive introduces mandating obligation for RFNBOs (Sipilä et al., 2023, p. 30), that are the focus of this thesis. The separate RFNBO mandate targets are for feedstock industrial use and transportation industry (EU, 2023/2413, article 22a, & article 25).

Industry (Article 22)

Although not the primary focus of this study, the article 22 defines the RFNBOs and renewable hydrogen's scope in the industrial context where hydrogen is mostly used as feedstock source and intermediate product. Hydrogen's industrial use is relatively small and therefore the mandate's target percentage of 42% by 2030 seems large compared to the transportation RFNBOs' 1% mandate by 2030. However, article 22b defines conditions to reduce the mandate for RFNBOs in the industry sector (EU, 2023/2413). According to official study from AFRY management consultancy (Länsisalo et al., 2025, p. 22-24) the revised directive's core challenges for the industrial use of RFNBOs include end-product's cost implantation, industrial competition both internationally and inside the European Union, and the general challenges, meaning electricity and technology's cost and availability.

Transportation (Article 25)

The article 25, both in RED II and III state the mainstream use of renewable energy in the transport sector. Key differences in the revised directive are the increased minimum mandate of all renewables and GHG emission reduction targets, and foremostly a distinct minimum mandate of RFNBOs part of combined advanced fuels target for the transportation industry. Member states must define legislation for transport fuel suppliers regarding RFNBO but are free to define the method and potential penalties. (EU, 2023/2413, article 25).

FuelEU Maritime

The revised RED sets a RFNBO mandate target of 1,2% since 2030 for the maritime sector by applying it to member states with maritime ports (EU, 2023/2413, article 25). Furthermore, the commission has introduced the FuelEU Maritime initiative, Commission's regulation 2023/1805 which goal is to reduce the sectors carbon intensity by 2% in 2025, up to 80% reduction in 2050. Foremost, the revised RED's mandates targets fuel suppliers, while the FuelEU Maritime (EC, 2023/1805) targets ships exceeding 5,000 gross tons with the purpose of transporting cargo or passengers (EC, 2025a, article 2). Therefore, there are RFNBO demand push factors for both supply and demand side in the maritime sector in Europe.

4.1.2 RFNBO value system

The value chain analysis explains how value is created in the different parts of supply chain (Porter, 1991), meaning differences of activities between stakeholders and explain relative prices and cost (Kontu, 2019, p. 27). The grounding foundations of renewable hydrogen value system are stated by multiple sources from the European Court of Auditors, consulting firms such as DNV (2024, p. 65) and Deloitte (2024a), academic research (Nemmour et al., 2023, p. 29014) and by solution providers such as Andritz (2025c, p. 35). According to Dulian and Erbach (2025, p.4) the key principles of renewable hydrogen production include hydrogen production, possible e-Fuels transformation, transportation of the product and the end-use. Andritz's (2024) model of e-Methanol production illustrates the importance of renewable sources in the production phase of the value system. However, the dominant industry logics are yet to form since the industry is only emerging. Combination of the RFNBO value system with stakeholder groups and the relevant EU regulation is presented in the **Figure 9**. In general, renewable hydrogen value chains consist of three primary parts. **Supply** of feedstock resources, **production** of the renewable fuels, and the **end-demand** for the fuels, as mentioned earlier. The relevant mandating/obligating regulation from the European Union's level for each part of value chain axis from supply to demand. Additionally, project developers for developing the hydrogen production plants, infrastructure, and different solution providers from

consulting to technological solutions are considered. Different rows are not in hierarchical importance, although the explicit focus on maritime end-use case.

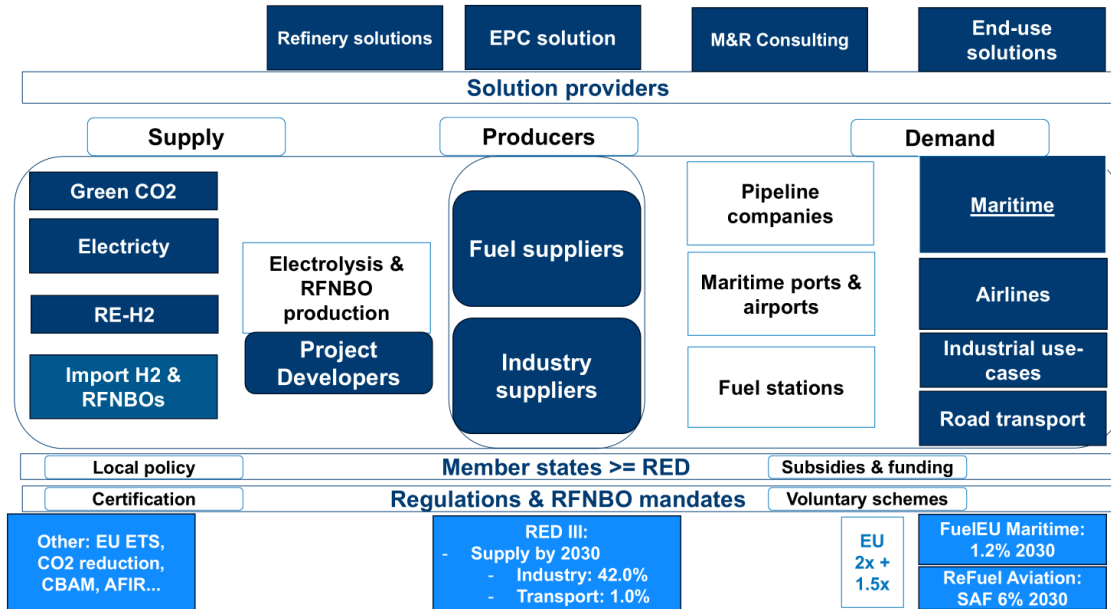


Figure 9. RFNBO value system and regulation (author).

The first phase, **feedstock** source **supply** for renewable hydrogen and RFNBO's production, renewable **electricity**. That is the energy carrier for hydrogen via electrolysis can be provided by utilities companies via grid, and also by directly connected to the production plants. The levelized cost of electricity (LCOE), is the main factor where is the cheapest location for hydrogen production (Secondary source 5; SuomiAreena, 2025a). The firms in this part consist of established utility companies with clear market position, vast energy production and customer portfolios but also agile startups (Interviewee 4 & 5). The electricity industry's producers are characterized by both established players that are private firms and public municipals as well as newcomers since renewable production is taking place. The industry is characterized by SPOT market trade, liberalization, net-zero goals and smart grid adaptation (Liesen et al., 2019; Rabetino et al., 2025), but most importantly these variables depend on the specific bidding-zone and country defining structural forces. Electricity price depends on many factors varying from weather, fuel prices, economic factors, policy and political atmosphere (Bhattacharyya, 2011). Fore-mostly, utility companies have incentive to produce premium product, e-Fuels since

electricity's price is falling from the rise of supply in renewables, confirmed also by an interviewee(s) working in the industry as well as secondary source 5.

Second, of e-methanol feedstocks, **carbon dioxide** has many available options for sourcing (Nemmour et al., 2023, p. 29017). Renewable CO₂ sources include biomass/biogenic sourcing such as pulp mills and forest industry that offer viable and scalable option to large quantities (SuomiAreena, 2025a; Andritz, 2024). Other CO₂ sources include Industrial flue gas and by-products. However, fossil CO₂ source's emission value chain does not meet the 70% GHG emission reduction target required for RFNBOs. Therefore, biogenic CO₂ sources, including pulp and paper mills have an incentive over the fossil CO₂ sources in the RFNBO value system. According to Andritz (2025c, p. 35) a single pulp mill can supply 2 MTA of biogenic CO₂ that can used to produce 1.2 MTA of e-methanol.

Fuel suppliers as a stakeholder group are specifically targeted by the RED III that mandates them to supply RFNBOs in the transport sector under the article 25. In the EU's RED directives, fuel suppliers are considered the party that is responsible for adding the duty tax on the supplied fuel and can be further defined by a member state (EU, 2018/2001, article 2, (38)). Specifically, fuel refineries do belong under both of target binding articles of the directive based on the EU terminology of NACE.REV 2 (EC, 2024b, chapter 2.1). However, allocation between the targets is defined on the basis of the end-product, energy-content or annual ratio of produced products (EC, 2024b). Refineries can produce variety of products from fuels to chemicals that can vary by weight and form from fuel gases, gasoline, jet fuel, diesel to solid fuels such as petrolcoke and bitum (Linde, n.d.) Moreover, hydrogen can be applied in various fuels production processes (Linde, n.d.), such as hydrodesulphurization, hydrocracking. The results of applying renewable hydrogen are reduced GHG emissions and increased share of renewables (Nemmour et al., 2023).

In order for fuel suppliers invest into renewable hydrogen solutions, the demand needs to be at sufficient level with sufficient price (Giehl et al., 2023, p. 10356; Tholen et al.,

2021, p. 5). This is where the RED III comes in as solution for setting mandating supply targets for fuel suppliers. The refinery industry is characterized by fierce price competition of achieving the lowest productions costs as possible (Secondary Data 5, coffee talks). As any other industrial process industry, industry logics are well defined. The ‘refinery route’ is the cost competitive way of achieving the RED III’s RFNBO transport mandates for early adopting (Hydrogen Europe, 2025; Secondary source 9). However, the green transition, especially the electric-vehicle penetration is assumed to reduce refinery industry’s market cap, at most extreme assumption by 75% in 2040 from between 156 billion USD down to 39 bn USD (Ding et al., 2022).

The **end-use demand** of RFNBOs divides to variety of sectors where RFNBOs can be applied as solution to reducing GHG emissions, and thesis focuses on maritime transport. The **figure 10** presents the total EU energy demand in transport sector was estimated at 278 Mtoe in 2020, 324 Mtoe in 2030, and 298 Mtoe in 2040, indicating decline in total demand, but increase in maritime and aviation sectors (The European Commission, 2021, p. 74). Out of the total demand in EU, fuel suppliers are obligated to supply 1% of RFNBOs in 2030 (EU, 2023/2413, article 25).

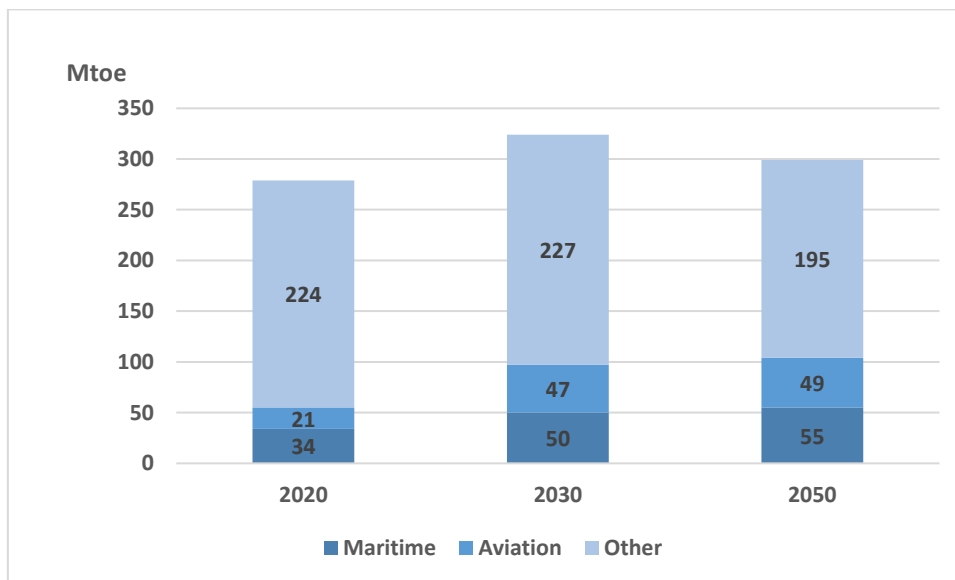


Figure 10. Total energy demand in transport (EC, 2021, p. 74).

The **maritime sector** is the backbone of global trade, facilitating approximately 80-90% of global goods trade by volume (OECD, 2025, p. 19; Möller, 2023). The top 10 companies control over 85% of the global trade (CNBC, 2024). The global maritime sector consumes 280 Mtoe of fuel annually, while fuel consumption for vessels over 5,000 GT was 213 Mtoe in 2023 (DNV, 2024, p. 34). Fossil fuels consisting of heavy fuel oil, light fuel oil, and diesel/gas oil, together were almost 95% of the 213 Mtoe, while liquid natural gas (LNG) was around 13 Mtoe in 2022 (DNV, 2024, p. 34). The EU's maritime sector's energy consumption was only 34 Mtoe in 2020 (EC, 2021). However, 42-50% of the global maritime voyages subject to FuelEU Maritime call port in European Economic Area's ports at least once annually (Secondary data 5; Transport & Environment, 2022, p. 4), in comparison 40% of the U.S. container traffic travels by the Panama Canal, and 12% of global shipping traffic passes the Suez Canal (CNBC, 2024). Overall, the global maritime traffic is subject to high volatility, affecting demand, revenue and profitability rates.

Heavy Fuel Oils (HFOs) are exclusive to the maritime sector (Secondary data 5; Andritz, 2025b). Foremost, the sector is subject to the European Union's Emission Trading System's extension (ETS) and the FuelEU Maritime regulation that push for GHG emission reduction and for adaptation of alternative fuel solutions. However, leaving the exclusive HFOs means the sector will compete against other industries and sectors for the supply of renewable fuels (Secondary 5; 2 interviewees). The alternative renewable fuel solutions consist of such as e-Methanol, e-Ammonia and Bio/e-LNG. Renewable LNG presents the most viable solution by existing infrastructure and foremost, by usability with engine and ship technology (Secondary data 5 & 10). However, supply and ramp-up are limited of all alternative solutions, meaning there is no 'either or' -scenario between e-LNG and e-MeOH (Secondary data 5). E-Ammonia is not considered yet since it presents highly toxic option, and requires high infrastructure, technological investments and adaptation to be a scalable solution. Although, e-Ammonia presents emission free solution.

Infrastructure and distribution development is key factor for the market development and trade of the RFNBOs (Deloitte, 2024b; Secondary data 1; interviewee 4). The existing

European natural gas pipeline network presents low-cost option for transferring from grey LNG to green but specifically hydrogen pipelines require new development (Hydrogen Europe, 2024). Therefore, so called 'hydrogen valleys' where supply and demand meet at SPOT-market -alike basis present viable solution for industry ramp-up and many are under development across Europe (Secondary source 2; Hydrogen Europe, 2024, p. 10). Foremost, hydrogen can be transported also by ships and trucks cost effectively, whereas cross-border development of pipelines requires time (Secondary Data 1). For reference, a cross-border development of electricity lines between France and Spain took 14 years just in permitting before building (secondary data 1). Finally, port authorities are in a key role of laying multi-fuel infrastructure for demanded quantities (Deloitte, 2024b).

Technology and solution suppliers/providers deliver the methods of achieving desired results. Whether it is the production of renewable hydrogen, fuel refining, engine technology, infrastructure or other. Renewable solutions do not commerce without solution providers (Deloitte, 2024b). Different stages of the RFNBO value chain have different solution needs. For the production of the fuels, solutions vary between position in the RFNBO value chain and how one wants to manage the project. While project developing firms can also directly deliver a solution but behold the project's risk before the owner acquires the completed project (Secondary source 5 & 6). Service offerings, Technology know-how and ownership as capabilities among other, distinguish different solution providers both in their own value system and the industry. The current P2X solution competition divides into two main groups: firstly, established players with robust turnover at 9-10+ figures USD focusing on variety of different sectors. Secondly, SME-startups focusing especially on the renewable hydrogen and fuel projects. The **figure 11** presents relevant EPC and engineering companies on scatter chart where X-axis holds average annual turnover, and Y-axis holds the average EBITDA between 2023 and 2021. Foremost, all established EPC providers hold positive EBITDA while greenfield startups hold purely negative. Key characteristics of the established EPC providers include engineering and technological capabilities, but variation by sector and industry focus, and geographic area.

Additionally, a key distinction can be forward integration into feedstock production and supply of industrial chemicals from firms such as Linde and Air Liquide.

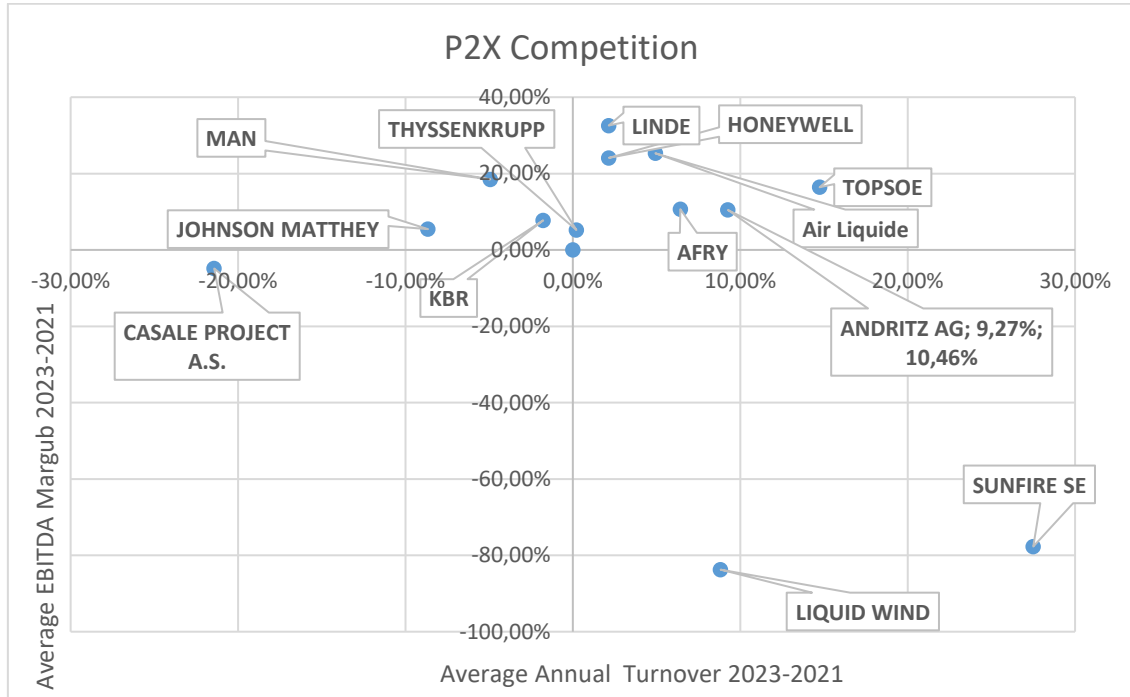


Figure 11. P2X competition: across strategic groups (Orbis data base by Moody's).

Hydrogen technology, meaning water electrolysis itself is not exclusive to restricted supply. Especially, the AEL and PEM technologies are publicly available. Although China is leading the supply of electrolysis' technology's raw materials (Pingkuo & Junqing, 2024). However, integrating the electrolysis solutions into refineries, feedstock sources, meaning the project of producing the fuels is what requires engineering know-how from solution providers. Especially, large volumes (+50-200 MW) production engineering capability requirements are larger relative to smaller scale.

Regulatory and managerial solutions, **management consulting** is relevant stakeholder group for the RFNBO industry. Compliance is relevant regardless of the step in the RFNBO value chain since the aim is to produce 'green', renewable products that fulfills regulation's criteria and not expensive non-compliant. Stakeholders can approach compliance in two ways, either Make-or-Buy (Secondary data 4). The lateral divides furthermore between

different expertise from management consulting, engineering, legal counseling among others. The lack of technology ownership either by developing it or owning licenses is the common attribute to them. However, firms in this segment, such as the 'Big4' -auditing and consulting firms, are often recognized as a trusted source, and foremostly, they provide solutions in other areas such as corporate governance and strategy. As interviewee 3 suggest, combination of all expertise is required to accomplish projects into business.

4.2 Regulation's meaning

The first empirical section analyses hydrogen regulation's meaning for business by presenting what it means for the interviewees. The findings confirm regulation's context for the renewable e-Fuels industry's formation: regulation is the basis of business and therefore it offers strategic opportunities. Firms that adapt and innovate quickly can stay ahead of competition, gain market share and strengthen their competitive advantage. However, the industry faces also variety of challenges moderated by the regulation: positive final investment decisions as well as actualizing renewable hydrogen business' progress relies on trust towards the regulation.

4.2.1 Antecedent of innovation

All of the interviewees advocate regulation's importance for the whole industry, its development and ramp-up. This is evident from regulation analysis as well as other secondary sources such as position papers. Initial assumptions are evident to conclude that regulation defines what are renewable fuels and foremostly, the offtake demand and market for them. Thirdly, firms must understand regulation's meaning for their own business at least in order to make any business. Especially, the emerging status, early stage of the industry's ramp up relies on regulation catalyzing the demand before natural demand emerges.

“Understanding regulation is a must for operating in the industry at all” (Interviewee 1)

“The whole industry builds up on regulation, and foremostly, every firm’s strategy begins and bases on the regulation.” (Interviewee 3)

“It is like everything in everything. The hydrogen economy is built on the basis of regulation. Without regulation it will not exist.” (Interviewee 9)

“In business like the green transition, regulation is what creates the market and sets the rules for how to operate there.” (Interviewee 11)

Combined with the context analysis, the interviewee statements indicate how regulation acts as the antecedent for business in the case industry, and therefore basis of gaining competitive advantage. Furthermore, hydrogen regulation’s relevance relates back to competitiveness of the renewable solutions against fossil options since the novel renewable innovations remain inferior in terms of financial viability when solely relying on natural demand. Regulation is an external antecedent itself where it is realization and result of politics. Moreover, it is a defining industry logic since without it the business will not flourish. Practically, regulation’s correlation with whether firms innovate or not is not explicit, but regulation determines how firms innovate. A following quote captures regulation’s importance.

“Of course, regulation is part of daily business because regulation defines the playground of the future. If you want to anticipate the future and make right decisions, you have to understand regulation.” (Interviewee 5)

On the other hand, the grand challenge of climate change is the reason for the regulation to exist. Interviewee 10 stated “special regulation” is required due to competition against fossils but also against other lower costing renewable solutions. Specifically, what the interviewees mean by building on regulation is defining the **offtake** which is the demand for the renewable fuels, and the conditions on how the fuels are to be produced. Secondly, particular summary quote from discussion with interviewee 2 captures the regulation’s importance regarding investment decisions into the renewable fuel projects.

“No FIDs (Final Investment Decisions) happen before regulation is set. Regulatory uncertainty is key variable for these, it affects how customers win subsidy auctions and biddings, bankability. Foremost, it sets the base for the offtake plans and agreements.” (Interviewee 2, 1st round summary)

Before making further conclusions based on regulatory changes, understanding **context** is essential. In the case industry, renewable hydrogen and e-Fuels regulation foremostly establishes the market’s supply and demand dynamics as stated earlier. It is the business opportunities by demand in which firms can engage, but such as specific technological solutions are left for the firms to find their optimal solution. The mandated change from fossil solutions to renewables indicates **system level change** in terms of supply and demand. Right now, ecosystem of renewable hydrogen trade is only emerging, but anticipating it remains essential for firms to make strategic decisions. In addition, guest speakers in SuomiAreena (2025a, 05:00) panel discussion advocate ecosystem’s importance from the transition to renewables and different parts coworking for success. In summary, where the whole hydrogen value system is one holistic unit of change, it consists of its parts having distinct system level change.

“Another big thing is that this will be a change to the system. As up until now shipping companies could basically buy fuel even on spot market basis or they could make some kind of a few-year contract. Now if they want to get these renewable fuels, they will have to make a 10 or 20-year supply contract and fix the price at roughly today’s price.” (Interviewee 7)

“I think the opportunity is that everyone understands that a change is coming and then some projects will begin as the early adopters. It is vital for them to succeed. In that sense we are not in a situation everything is forgotten and set back. But of course, the phasing and risks are bigger in these first projects.” (Interviewee 8)

“It is essential for us that a hydrogen economy’s ecosystem is created in [country] before and that its promising. And of course, that we have the hydrogen ecosystem in place before we can make significant investments into the [sector’s] projects. It is a bit of a chicken-and-egg question as which comes first, but of course we have a strong view that there is an urgent need for infrastructure readiness in order to any ecosystem to emerge. Through that we work with our customers at the grass-root level. So, in a constant dialogue with those companies that would use the infrastructure.” (Interviewee Anom.)

Finally, regulation offers avenues for novel business by mandating change for expensive novel solution, renewable hydrogen. According to a report from McKinsey & Company (Granskog et al., 2025) the top three reasons for incumbent firms to invest into renewables technology are potential business opportunities, decline in existing business and regulatory push. Similarly, interviewee 7 agreed that the climate change is “damn big opportunity” for making new business. On the contrary, the top reasons hindering investment decisions include technology’s relative cost competitiveness, but also practical issues such as infrastructure readiness (Granskog et al., 2025). Furthermore, investments into renewables can be also cultural question regarding pure profitability as a quote from coffee discussion with an ex- oil and gas professional shows. On the other hand, a review of ExxonMobil’s 2024 annual report to shareholders (2025, p. V, 4 & 43) indicates that incumbent firms recognize hydrogen’s relevancy in the future but acknowledge them too expensive as of time being. In comparison, Neste (2025, p. 21 & 22) in their 2024 annual report is showing clear emission reduction tacking as well as re-evaluating their hydrogen project for Porvoo refinery.

“The American oil and gas companies are playing much dirtier (oil production) game compared to the European producers as I’ve seen. As if they don’t care about it.” (Coffee discussion, engineer)

4.2.2 Regulation’s challenges

Where regulation is an independent variable as antecedent creating the hydrogen market, actualizing business based on regulation is challenging. Although the EU directives and regulations are clear and comprehensive on paper, variety of barriers and frustration emerged between the interviewees that undermine their effective implementation. Understanding challenges is important because they impact how and where firms can engage in the renewable hydrogen business, since the projects involve cross-sectoral planning and optimization.

Demand. First, as much as regulation is the enabler of the hydrogen industry, the interviewees advocate it is delaying investments. Untrust and reliability of regulation hinders

investment decisions since challenges in one part of value chain reflect to other parts. Demand offtake is directly mediated by regulation, which in return impacts investment feasibility. Demand reliability is key indicator of whether firms realize specific investments, meaning engaging in that business. However, whether one engages in business by specific product types and “portfolios” as interviewee 10 mentions, versus overall corporate and portfolio strategy, bases rather on firm strategy than regulation. Additionally, these arguments further elaborate the importance of regulatory position due to the system level change.

“(The RFNBO mandates are) as good as its implementation in the member states’ law; Remains to be seen what opportunities this opens over the long term.” (Interviewee 1)

“And then the second challenge regarding demand uncertainty is real. It is hard to get over, it becomes more relevant with financiers.” (Interviewee 10)

“Well, [an oil & gas company] delayed their investments partly because the planned mandate levels did not support their project’s size.” (Interviewee 9)

“And currently there is not enough supply (of e-Fuels).” (Interviewee 8)

Politics and regulation predictability emerged the main concern regarding the green hydrogen and e-Fuels’ ramp-up. Trustworthiness and longevity are key factors for making investment decisions because first, whether the RFNBOs, renewable hydrogen have mandated demand, and second, on which basis focal projects’ value systems must be optimized. Especially, with e-Fuels such as e-methanol that require robust end-use adaptation, regulation’s reliability becomes times higher concern. Ultimately, the mandating regulation is as good as it is enforced. The reliability concern arises especially with bankability and being able to secure financing (financing discussed in chapters 4.3.1-4.3.2). As interviewee 9 stated, a core issue when implementing regulation is that who will pay for the mandated demand which creates pressure on policy makers.

“They (regulations) are a bit of moving target in the sense that when politics change in the world, it kind of brings certain challenges. That OK, something is happening or something is coming, but will it go through and in what form?” (Interviewee 8)

“Can you trust that the regulation will not go backwards because they are so expensive and especially then people think about what the acceptable way is to reduce emissions.” (Interviewee 10)

“Either the end user has to be forced to buy with the mandate, or society has to find a way to collect a bit more tax from somewhere and support it, but in any case, this has to be paid for, and regulation is how that should happen. It’s a good question how to push such regulation forward because typically, especially if we look at it from a politician’s perspective, the situation can be quite difficult if voters have to pay more.” (Interviewee 9)

Furthermore, regulatory risk of the potential change relates back to the competitiveness of the RFNBO-based fuels against other fuels and potential technical solutions. Altogether, uncertainty of changing the regulation, mandates increase the risk that investments will not remain anticipated profitability in the future. Specifically, higher the degree of adaptation between different value chain parts, greater the barrier. On the other hand, fuel supply mandate’s fall back in other countries poses international policy risk for demand, as the case of Swedish Biofuel mandates withdrawal impacted Neste’s export strategy (Mäntylä, 2025). Essentially, a “lock-in” risk of executing project with set return expectation against regulation.

“These revisions in regulation (Renewable Energy Directive) are fundamentally good when they lead to an increase in demand. However, as long as the revision just means that it is a large unknown uncertainty creating question mark, it will paralyze the development of the market for a long time.” (Interviewee 3)

“Yeah, there are really huge risks in play. In monetary sum, [--] you have a 100-million-euro ship that requires 400 million in land-based investments. So, yeah, the shipping company must be committed to buying those fuels so that someone makes the 400 million investments.” (Interviewee 7)

Where progress and reliability of the RFNBO mandates in RED III and other policies rely on elected politicians, the interviewees advocate that the sheer size and amount the different regulations makes a distinct challenge. Managing between regulation on different areas and sectors increases firms’ burden by the amount. Regarding the ecosystem, an observation among the interviews was that policy balancing between different value

chain steps poses challenge since, if a particular stakeholder is not incentivised by regulation, it poses liability to other parts. Repeated among the interviewees is infrastructure's readiness that is a practical issue but related to regulation.

"The clearest challenge this [hydrogen regulation] has is that this whole thing is just so damn complicated." (Interviewee 11)

"When you think about how much regulation there is and how complex it is, that we most likely do not have any person that could really evaluate regulation's whole economic impact, potential business cases for companies or the market development let alone for a single case. So, in my opinion the challenge is that we have created so much regulation. It's possible for one person to take over one area and follow them, but to have one person who understands absolutely everything about this, that sounds like there is not that many." (Interviewee 3)

"Regarding hydrogen legislation, the challenge is that regulation has been created for products that essentially did not exist in the market, and then substantial and significant mandates and goals have been imposed on that product." (Interviewee 11)

"So, when it comes to what is going to happen in the future, it is still an open question but there will be cross sectoral competition. When we look at the maritime sector, there has been relatively cheap fuel and now it is going to the other extreme side" (Interviewee 8)

Finally, regarding political risk of regulation, trust in the regulatory framework is another key conclusion from the interviews. Interpretation of legislation poses risk itself. Where political risk from election's volatility can be anticipated, as oil company St1's founder Anttonen summarizes (Mäntylä, 2025), some interviewees advocate legitimacy of legislation and institutions poses another concern. Especially, interviewees mention the European Commission's Q&A documents particularly because potential legitimacy of institution cannot be predicted enough.

"Now there are these new legislating instruments that are the Commission's Q&A documents, that are not part of normal legislating process' result. Instead, just clarifying documents made quickly and there are interpretations to come. [author: and it's the European courts that make final decision how these are interpreted] And that is the type of risk that no company will take." (Interviewee 3)

“We see the Q&A things like really problematic since this is not the first place where they show up. First a law is implemented, and then afterwards comes like this non-binding legal text that could change in the flight. It defines what that law should be followed, and it is not good legislation that the Commission has such goals, then the EU institutions, the Council and the Parliament come and say that some your goals are not suitable now. Then it is decided that now in this form and the afterwards the Commission tires to push back those original goals that have already been rejected in that legislative process through this Q&A. [--] Regulation should not be a risk at all.” (Interviewee 4)

4.3 Regulation’s strategic impact

The second empirical findings chapter analyses regulation’s impact on sustaining competitive advantage. The findings focus on how regulation moderates the steps of business process after the antecedent of change part in the framework (figure 4). The most evident results: regulation affects every firm’s strategy in the renewable hydrogen industry since every firm’s strategy basis on that. Firstly, regulation moderates the industry and demand dynamics, and how focal firm engages in business is result of regulatory position. Secondly, regulation defines benchmark standards of business. Adopting both strategy and actions regarding regulation yield competitive advantage.

4.3.1 Firm strategy

This first sub-chapter examines the findings regarding regulation moderating firm strategy in the industry. Sensing business opportunities through regulation is actual since regulation itself is antecedent. Regulation defines market conditions by geography: firm’s location impacts where and how business can be done which then affects optimal business model. Moreover, both firms’ strategic position in value system and the managerial choices are moderated by regulation. How regulation impacts specifically, is case dependent always as the interviewees mention. This can be recognized not only from the industry value system analysis between incumbent industries and greenfield startups, but in terms of where projects locate by energy investment characteristics. Overall, firm’s

regulatory position determines the level of competition and business models in which to engage by how firm engages in business based on regulation. Essentially, regulatory position is which different regulations are relevant for a focal firm's business, and part of that is understanding how regulation is relevant to the other parts of firm's value system, a strategic variable. Altogether, a mirroring sign of the regulatory position is the level of risk exposure a firm holds.

“Regulation is what creates the market for the hydrogen economy products. In a way an important part of your business strategy is handling it, understanding it and at some degree influencing it. At least recognizing of the laws and on the other hand, understanding its context in which regulation steers for certain business actions.” (Interviewee 11)

“This business is defined by regulation so any firm must have if not perfect, at least very deep understanding of the regulation.” (Interviewee 1)

“So that we get the first plant before 2030, that we achieve this strategic position, and we can conclude Ok, we can deliver plants. I would say that we won't tackle with bigger players and cause of that we have not chosen China. Lot of P2X is happening there but now there is not just readiness to compete with the Chinese because they can operate much more efficiently. Until we know exactly what needs to be done, it is difficult to go compete in China. (Interviewee Anom.)

First, a conclusion based the interviewee's stance on regulation is that firms and managers must understand the relevant regulation to their business. The market dynamics, industry logics is the foremost topic that impact firm strategies. Other strategic topics indicated by the results include product standards and development, and firm's location's, geography's regulatory framework. In order to develop offerings and products, firms must be able to comply with regulation, norms and standards.

“The first dimension when you get in touch with regulation, of course in product development. That means if you want to develop a product, it needs to be in line with a lot of norms, which are not only set by governments, but also by ISO or various organizations. You have to understand what the relevant laws are, for instance CE, what are the norms for building an electrolyser. So, that was my first contact with regulation.” (Interviewee 5)

“One of the important tasks before you start any development is you have to understand what the regulatory framework for your development is and how do you comply with the rules of regulation for a certain region.” (Interviewee 5)

“Yes, necessary in order to develop product standards, that implicate, if you are following the standard, it is enough as well as a weaker standardized product will not out compete mine from the market. It creates the trust towards the system that it is known you can chemically confirm it easily which this product is produced. So, it also creates the safety through that, trustworthiness of the whole system. If you lose the trust on the system, it becomes difficult to approve this type of expensive (carbon/emission) reduction methods politically.” (Interviewee 10)

A countering argument, the interviewees express differing views on how regulation can be source of competitive advantage. The development of technologies and solutions corresponding with regulation is recognized as a source of distinction, competitive advantage. Especially, some argue regulation itself does not create differentiation since the molecules are the same, but regulation determines which methods are acceptable. Furthermore, it is the regulation that then determines feasibility of different solutions by how much not complying is penalized. Indicating how, where and when companies can compete with their offerings and projects. The European Commission’s delegated acts (1184/2023; 1185/2023) on the RFNBO-verified electricity criteria are an example of this because as interviewees 3 and 10 mention, it is about finding the best technical solution that is the most feasible with the requirements. Moreover, penalties are a major factor for determining potential case viability against not complying. Overall, the production criteria set by regulation relates back to the offtake conditions’ development regarding what regulation requires and what is actually possible.

“Regarding the timeline of this future, it is very difficult to predict it exactly as the regulation is still somewhat in mismatch with reality and there is significant discrepancy between regulatory requirement on sustainability around the world.” (Interviewee 1)

“I note here that regulation is always from the ‘outside’. So, inhouse competence is just copying and understanding what happens outside. There is not regulatory innovation or similar competitive edge related to regulation, and no one can patent their way out of regulation.” (Interviewee 1)

“Norming organizations are quite important and, they also are defining the field of competition and can exclude other companies from other region or companies which don’t understand that. That means as a company, if you want to be successful in product development, you have to understand the regulation, find the best technical solution to comply with this regulation. What is the cheapest way to do it? Then you enter into an environment of competition based on your understanding of regulation. So, it’s a very important field, in industries like medical devices it’s basics.” (Interviewee 5)

“The product standards impact what kind of components and how you need to manufacture them. And then if the standards are stricter than elsewhere, the projects become more expensive to build on that set geographic location. And based on this, the projects’ competitiveness is lower and their probability of being realized gets lower.” (Interviewee 10)

The second side, a result of regulatory position involves understanding other stakeholders and value system parts’ regulation. Changes in other areas of the RFNBO value chain have direct impact on supply and demand dynamics, and regarding one’s strategy and business model’s viability. Of course, all relevant regulation should be considered part of managerial decisions regarding strategy. Specifically, conclusion of the interviewees’ stances is that regulations create dynamism into the industry dynamics that understanding of which goes beyond focal firm’s own scope. Furthermore, regulatory position is not only regarding competition between one’s own geography’s regulation against other geographies, but also about competition against different lead markets, sectors. Especially, in the downstream end-use, industrial usage of hydrogen goes beyond fuels to areas such as farming, chemical refining and sustainable steel production (Interviewee 5; Secondary source 10). The statement is backed by the limited actual growth compared to how the required growth, and renewable fuels competition in maritime sector’s e-Fuels against other fuels as well as other industries.

“Of course, regulation impacts differently depending on which part of the value chain you are” (Interviewee 1)

“The regulation which defines the business of your customer. So, you have of course competitive advantage as a supplier if you understand the regulation of your customers because you can address them” (Interviewee 5)

“Can you make the project? You can plan a project throughout and really well. You can optimize it against all the regulations and challenge is that it is very difficult to understand your own competitiveness in relation to other regulations. That you can, for example, --, someone has developed a project somewhere in the world but then if you look at it elsewhere, the whole project has to be thought differently. And then, because the regulatory situation, even how renewable hydrogen can be produced there is different, then what kind of requirements are involved or how it works and that is difficult. Of course, it can be solved with expertise and time to understand, but it is complex.” (Interviewee 10)

Where the managerial decisions made based on regulatory position impact firm’s engagement in business, another aspect of regulatory strategy is how a focal firm influences, advocates regulation. Conclusion of the interviewees is that having an inhouse capability for understanding regulation is essential but approaches on how firms engage in business based on regulation vary between two polar examples. **Proactive** firms engage in the renewable hydrogen business regardless of regulation and legislation not being finished. Specifically, these mean planning business, actualizing hydrogen projects and lobbying regulation. In polar opposite, firms approach the industry in **moderate** way. Furthermore, the moderate approach divides between two categories by ones that only approach at small scale with experimenting. The second wait-to-see how regulation is set up before making decisions towards hydrogen business.

“I think everyone in this industry understands how critical understanding regulation is. It goes with firm’s strategy that there are firms which are very strong pioneers and want to make things happen first and then there are companies whose strategy is more to follow the change and then act when its certain how the regulation will be. And both of these types are present on all of these sides (of the RFNBO value system). When thinking about producers, some of them want to be first movers strongly. [project developers] have come out with ambiguous strategies and then there are firms that certainly are interested in this but move with moderate approach. For example, [utility companies] have announced these smaller demo plants, that they have something coming, but they are starting out with a smaller one. And then, there are actors who haven’t yet announced their project but are planning hard. So, there are definitely different strategies. It all depends on what type of actor they are, what kind of risk tolerance they have, how well hydrogen fits into their company’s strategy, and what kind of potential they see in their own customer base.” (Interviewee 3)

“What kinds of positions there are on hydrogen regulation, there are so many different positions among [energy] companies. Like there are renewable energy

produces who are interested in opportunities to make long-term supply contracts and can easily sell electricity to hydrogen producer [--]. But that is not necessarily compelling specifically for industrial customer that wants steady supply. But then in the case of renewable hydrogen, the regulation's volatility matches the supply by far. [--] Then there are these [names of established utility companies] that have wide portfolios with both steady and volatile energy production, and they also have more industrial customers that buy the steady supply. They then have much different stance for this RFNBO-regulation, and do not like the regulation's volatility at all." (Interviewee 4)

The reactive way, lateral part of interviewee 3's statement is backed by two arguments. First, incumbent process industry logics apply in the system level change, adaptation and innovation from grey to green. Second, firms in incumbent industries have number of reasons to avoid entering the emerging hydrogen industry. Risk avoidance is characterized between variety on causes with uncertainty being the ultimate factor. Regulation itself contains risk and how policy is managed by officials in a set country or region impacts the business opportunities there directly. While regulation's uncertainty is one part of risk avoidance, limitations in differentiating from firm's core business support the argument. Especially, in the end-use and end-demand sides.

"Like these heavy process industries, they do not really have any reason to be the first in the (hydrogen) market. Instead, they have all the reasons to wait on how things begin and how competitors move. [--] They should definitely not allow any project developer to enter their business area but instead wait and see how things begin and hold in their own hands the management of these projects." (Interviewee 4)

Furthermore, trumping the idea of incumbents entering hydrogen business, as well as horizontal integration become controversial because focusing outside core business poses to "business risk". Rather effective strategy of integration is co-participation in project management as the interviewee 10 mentions. The 'pool' of fuel availability in terms of renewable hydrogen projects is so large that the end-users do not need to enter the production. On the other hand, electricity production for hydrogen production is incentivized by lowering energy price of renewable while their supply rises. However, fuel refining is outside utility companies' business. In conclusion, the incumbent firms gain advantage from being able to bring their core business understanding to the industry.

“You have many EPC players which have established business in the process industries and for them, it’s just a next step to move into that field. And I don’t see anybody coming up from the medium level side to that business because the projects’ risks are so high, financial power is so high.” (Interviewee 5)

“Yes, a variety of combinations can be made there. The challenge is that if hydrogen is more tied to infrastructure, and fuel producing carries more of merchant risk, leading to different risk levels, where the higher capital cost for that expensive hydrogen production investment is also higher. And a renewable fuel producer cannot really integrate forward, but instead then some maritime operator can also decide to be an investor with either small or large stake. Then even at hold-co or top-co -levels, meaning the overall level of project developer or as an SPV (Special Purpose Vehicle) in individual projects, where they have a stronger interest and are well acquainted with those projects.” (Interviewee 10)

Finally, as mentioned already, in addition to determining how firm engages in business, the findings suggest regulatory position and strategy mirror the **level of risk** a firm is willing to take. Considering, how much uncertainty the interviewees state regarding both regulation and practical development, early-movers certainly bear risk. However, result of early-mover strategy is achieving market leader position. On the other hand, the risk of complying the regulation, such as the RED III’s mandates before any have been penalized practically makes the business viability fictional.

“At the same time players have also the risk that the mandates stay active, and you do not get penalized from not following the mandates. So, like, you have the risk of taking risk that you comply with the regulation’s mandates. Or you take the risk of not complying, potentially paying penalties. This is very, very new situation to many companies.” (Interviewee 3)

“The startup disadvantage is huge because you have to have finance and build up your own business as this, this business completely on the new green molecules and you are relying on earning all your profits there. But if you are company with let’s, say which is active in the grey world and the old fossil world, you have of course revenues there also today which you can use to finance your transformation to the green molecules, which is much easier.” (Interviewee 5)

“Then again counter party that is an e-Fuel player, they have the regulatory risk, and they also have plenty of other risks, project management risk. So, that way risk management is challenging and if we think what about where the e-Fuel is sold to. Many firms can question that whether they are ready for it being cost plus mechanism, meaning they take larger risk from electricity’s price. Which is

the kind of risk they are not accustomed or willing for. But then if you sell it as fixed price, you have the kind of risk position in the production that it becomes difficult for you to make the project. And you must be able to manage that throughout the whole value chain. As if Pay as produce PPA, accept that.” (Interviewee 10)

“How this comes back to regulation is that can you question what kind mechanisms would support that these projects’ risk levels could be brought down because if regulation changes, you might not be able to operate the plant anymore.” (Interviewee 10)

In addition to regulation’s impact on firm strategy, **horizontal and vertical integration** in the RFNBO value chain was an emerging topic of discussion. Depending on value system position, forward and backward integration are lucrative idea in renewable hydrogen production since the industry is emerging, lacking clear market leaders and the structural forces are not measurable by actual performance yet. Especially, the ‘complex’ electricity supply rules make it that energy producers could produce fuels since electricity price decreases as amount of renewable production rises. However, the interviewees trump the idea of incumbent firms integrating, at least outside a firm’s core business due to high uncertainty as the interviewee 4 suggests.

Instead of horizontal integration, the interviewees do advocate the importance of **partnerships**. In essence, the industry’s development relies on the value chains development as well as on technology development. Partnerships offer strategic benefits such as business model bundling, where two or more focal firms excel each in their distinct focus area, complementing each other. Project management is especial example of this: one provides the electrolyser technology and other partner manages the EPC execution. Similarly, Fortum has announced smaller demo projects with different partners including demo e-SAF production for Finnair (Liquid Sun, 2025).

“Those technologies we must partner with someone.” (Interviewee 6, 1st round)

4.3.2 Business model and regulation

Overall, **business model optimization** is the core aggregating result through which firms translate regulation into competitive advantage, regulation is not an external constraint. How business models and business model innovation, both moderated by regulation contribute to firm competitive advantage begin with the firm's regulatory position. The business model optimization becomes a question by which approaches fit for the focal firm's core business and strategy the best based on regulation. Essentially, optimizing means findings the best, optimal technical solution to produce the most competitive product.

A majority of interviewees emphasized regulation's explicit input in financial planning and project management. Specifically, interviewees state that it is about finding the best technical solution and increasing efficiency that drive competitiveness since the effecting regulation is the same for everyone. The same is stated by the Neste's technology leader, Lindfors suggesting that innovations with lower cost structure gain competitive advantage (Mäntylä, 2025). Firms must recognize which regulation they are subject to, and gain knowledge of it because as mentioned it affects the case viability directly. Altogether, the interviewees' statements indicate regulation as a core part of value creation in business models. Maintain regulatory expertise and capabilities are an essential realization of firm's regulatory strategy and core part of key resources.

“Regulation must be complied with, so that it is considered part of all financial calculations and like in market analysis and so on.” (Interviewee 1)

“For us it is analysis regarding how it (regulation) affects the demand of our products in the market, and how it affects our projects and our business cases and overall, our whole business.” (Interviewee 3)

“We approach it in such a way that its (regulation) expertise is part of strategy that it is not something external. It is also not something that cannot be outsourced if you are in a business whose business concept and financial results are based on regulation. So, then that expertise must be in-house that you cannot outsource it to an organization or other actor, but you must have the competencies to anticipate, read, influence and draw conclusions from it for the development of your own business.” (Interviewee 11)

The most evident conclusion regarding business models is that regulation defines business model feasibility in the hydrogen industry. The statement bases on the earlier mentioned finding regarding market dynamics, offtake' conditions and demand's formation.

Secondly, in order to meet the demand, the renewable hydrogen regulation determines requirements of the production. Regulation holds multi-sided impact: **value chain reliability** and management emerge key topic regarding what is possible in terms of meeting the mandated demand. This relates back to what is technically possible and what regulation demands. Furthermore, a controverting argument rises between how much regulation creates business, and how business is actually made. As the CEO of P2X Solutions, Herkko Plit states they produce products based on the customers and what they demand, (SuomiAreena, 2025a, 38:00). Moreover, as interviewee 10 stated, and Plit (SuomiAreena, 43:00), the price of carbon dioxide determined by regulation that creates the demand. In other words, the end-customer of the renewable fuels is the main question where regulation influences.

“To make investment decisions, that is what regulation is. It’s the demand creator, it gives you the framework, so how do you source electricity, how do you get carbon dioxide, how do you operate the plant. That defines the business case, and by that defines the price of your product, and then at the same time it defines whether there are customers for your products or not.” (Interviewee 3)

“The mandate revisions are things that are in the minds of both producer and customer. If the customer does not have target, then why would they pay for more expensive product. And if the mandate is unclear for producer and there is the target and the customer, then you cannot construe your position in the market” (Interviewee 3)

“What is the optimal technical setup to produce the most cost competitive product at select location. It begins with that what kind of power purchasing mix is, it can even start with what if you invest into upstream, what kind process wind-solar-BES or other set up there is, how do you optimize storing the hydrogen. And in addition to these, are you ready for not everything being RFNBO, so how do you optimize the RFNBO versus low-carbon’s ratio. And then how do you develop the project, how much optionality do you need in the contracts that if for example, nuclear energy’s role in regulation changes in the future, then like how would let’s say grid mix work, and like what do you want to keep open as option [--]. What

would seem the best in terms of the risk-return ratio in relation to the costs.” (Interviewee 10)

“Yes, competitors do think of this in similar way. And it is more about who finds the right customer and the project that gets to the finish. Like now we have lot of customers here, but we are not talking about FIDs yet. Now that regulation is uncertain, we do not dare to take even the FEL2-stage decisions because of regulation.” (Interviewee 6, 2nd round)

The results indicate that strategy acts as a key intermediary between regulation and business model and its innovation. Notable, this does not negate the fact that regulation affects business models directly in the case context, by articulating business opportunities that in turn influence opportunities reflected by strategic orientation. As the interviewee 3 mentions, regulation determines the technical solutions for products, and whether the products have any customers. Although, the strategic approach firms adapt articulates the technical solutions, but that is not be related to regulation so much as interviewee 5 argues. A common view among the interviewees was that regulation is clear on paper but actualizing it via business becomes complicated and challenging. However, business model/case optimization is holistic approach to gaining competitive advantage by including capabilities to make regulation into business.

“Regulation is clear on paper, but then the implementation side is challenging, and maybe exactly there we get to the hydrogen production plant.” (Interviewee 4)

“They (e.g., RED III & Delegated Acts) are easy to understand but not easy to implement, so at that point there becomes the need for hydrogen storages and other [Author: sorry, so optimizing production practically?] exactly! Also, the need for infrastructure, so if there was a hydrogen pipeline somewhere connected to a storage, it would do the job. But as long as the pipeline infrastructure does not exist, the timely correlation is pretty challenging. Really, only those end-use customers that accept the volatile production can be serviced.” (Interviewee 4)

“An early mover understanding requirements of the business case of the customer, maybe not so much regulation in this case, but that's definitely an early mover advantage when you understand the full needs of your customers” (Interviewee 5)

“Regulation creates the conditions for whether a project can be initiated or not, but there may be conflicts regarding the clarity of regulation. There are so many specific issues that, and only at the end, can the project be optimized?” (Interviewee 10)

Regarding business modelling, managerial choices on strategy determine which kind of products and solutions a firm decides to offer. The chosen strategic approach defines value proposals and the best solutions for creating them, and what are the best performance metrics for tracking and defining performance’s progress. Furthermore, as interviewee 5 suggest, winning against competitors comes down to convincing customer that the proposed solution offers the best value.

“The view of [wind mill technology provider] from the very beginning was always on the total project levelized cost of energy and not the CAPEX of the wind turbine. That means they optimize the project with the right selection of the wind turbine when they are to make the proposal to customer and say, OK, you have a project here. What is the location, what other wind speeds and how that does not change over the years. So, they were able to analyze and mix best offer which was a technology selection 1st. And from the CAPEX it was never the best, it was always one of the highest. [--]. They chose a more expensive solution to have a more reliable wind turbine.” (Interviewee 5)

As regulation determines both the customer and product, it foremostly indicates where the customer is located, as interviewees 3, 9 and 11 mention. The RED III’s mandates indicate potential export opportunities, determined by firm’s geography and strategy. On the other hand, getting fuels to customer is moderated by infrastructure readiness more than regulation, but moreover, building infrastructure becomes hard without market existing. All of the interviewee’s agree that before any pipelines are built, it must be known who buys what, and where the product is to be transferred to. For example, interviewee 4’s response:” Exactly!”

Financing emerged with several interviewees as closely linked with hydrogen regulation. Together financing and regulation contribute to gaining competitive advantage by securing bankability. Across all levels of the value chain, project financing is influenced by the regulatory context. As noted by the interviewees, project feasibility hinges on the regulation that impacts the offtake viability. Both of which are in critical part of early-stage

bankability assessment by financiers (Flink & Kuhn, 2025). As interviewee 10 mentions, the concern regarding demand uncertainty “is real” especially among financiers. On other perspective, project management and financing capabilities are another concern which correlate by focal firm’s size and experience. What regulation ‘demands’ impacts firm’s ability to manage project, and competitiveness against other regulations based on the offtake analysis.

“You get visited by local project developers that are not strong balance sheet companies and then, the foreign rivals could offer clearly cheaper (offerings).” (Interviewee 10)

“First of all, if you want to do a multimillion-dollar project you need to have the financial power to finance it. So, lot of the small electrolyser startups are not able to go to the EPC-level because their financial strength is not there. And also, the customer will never give a million, multimillion order to a small company because the risk if something happens, it’s quite high that you will never get your money back.” (Interviewee 5)

Furthermore, project management capabilities impact financing power because managing invested capital in order to achieve targeted returns. Relating back to regulatory and value chain positions, achieving project marginality correlates especially with one’s core business. As interviewee 10 mentions, this extends beyond downside risk into projects cash flow. Under regulatory uncertainty, this translates into solvency issue: whether a project is even feasible by achieving revenue with existing regulation before even profitability is considered. Similarly, interviewee 6 advocates that calculated project returns at current assumptions determine whether customers engage with earlier stage projects and planning. While regulation determines feasibility of the projects, that is the offtake development, other aspect is the ability to deliver projects within expected costs. As observation, project management experience is as good an idea as firms get to realize it, where a result of gaining this experience contributes to gaining first mover advantage.

“Many offtakes case are not feasible in the sense that financier could invest into the project based on it (offtake). It requires a very solid balance sheet company, and in addition, the contracts need to be quite strict so that the project can be financed.” (Interviewee 10)

“Most buyers may lack the understanding, capability or willingness to take on for instance, the price risk of renewable energy or energy price risk in specific market. If that energy is purchased merchantly, then the price is formed from the electricity market. Additionally, when you try to finance projects with a typical project having assumption of 12-15% IRR (internal rate of return), it is able to achieve an NPV of zero somewhere around 7-8 years. You need at least 7-8 years for the projects to at least offset the downside risk. It is a really long-time frame for many positions, because if you make long offtake agreements, you also take large business risk yourself. If for example, airliners made long and large offtake agreements now and regulation changed, they could not get out of them anymore. There is a solvency issue that can lead to the questions of whether the financier even sees those offtakes as being viable if they see that they can put that counterparty at solvency risk.” (Interviewee 10)

“I see two types of financing for these, meaning there are those who can take on a lot of risks and start producing with risk, likely the oil companies can do this. Very few can. Others will be making these 15-year contracts and will be seeking safe bankability, and the whole value chain’s bankability challenge is quite significant. And this is influenced by regulation.” (Interviewee 8)

Furthermore, what the findings indicate is that project financing is global competition on the basis of investor return expectations. However, a couple of interviewees mentioned a solution for gaining capital other than private: public funding. First, different public funds, such as the European Hydrogen Bank and auctions are often part early-mover project financing (The European Commission, 2025b). Especially, these allow startup owners retain ownership while accessing capital with lower return expectation, thereby reducing investor exposure to risk. However, as the CEO of the Finnish Teknologia Oy Minna Helle and the CEO of pension fund Elo, Carl Petterson state, hydrogen industry must emerge with the private sector’s companies leading it (SuomiAreena, 2025b). Second observation is that funding allows to develop capabilities. Especially, R&D funding such as Business Finland’s Veturi program allow firms to develop technological solutions as well as retain key knowledge in companies.

“Project competitiveness becomes also regarding capital expenditures. There is the Middle East, the USA might have interest especially in the Middle East, maybe in Asia, in China, to wait and expect lower returns from the first projects. So, that market share can be gained. And that creates even more competitiveness challenges for European projects to find customers if you can purchase it clearly cheaper from elsewhere.” (Interviewee 10)

“Well, in moderate sense, who owns plants is a bit of a question. It’s probably still not known, but definitely the financiers define it, and where the capital comes from, they are then de facto the owners of plant.” (Interviewee 1)

Risk management as activity emerged especially between finance and regulation. Moreover, value chain position determines which kind of role a firm can and should take in managing projects since they correlate into risk profile and marginality but also into gaining experience in the emerging industry, as mentioned in the chapter 4.3.1. Overall, the interviewees mention risk management in the managerial strategic decision making, than as ‘practical’ activities. Although, particular quotes were mentioned by two interviewees. First, interviewee 3 suggests risk management part of contract management, also mentioned by interviewee 2. Second, health and safety management were strongly advocated by interviewees 5 and 6. Especially, due to hazardous nature of chemical process industries, public perception can strongly impact political support of the novel technologies.

“I like to talk about increasing awareness, like finding strong partnerships as well as finding the risk management models for new contracts. Like, we operate in a new market, so we have to dare to think about things in new ways.” (Interviewee 3)

“I’m always concerned that if these very small startup like companies do large projects that have as in safety issues or HSE as health, safety, environmental issues, which to then the public view says, OK, this is too dangerous and change the picture. So, I’m very afraid of all these new companies that often are small teams trying to do big things.” (Interviewee 5)

Network management: dialogue with customer and stakeholder regarding regulation was brought up by some interviewees. One aspect of this is influencing policy making, lobbying as mentioned in earlier quote from interviewee 11. Second, business realization and impacting own interests and benefits. Furthermore, dialogue means beyond just communication but actual **stakeholder interaction**. Co-operation via lobby groups, industry groups is actual since policy makers must and want to hear what is actually, technically possible from the firms. Overall, as the guest panelists suggest (SuomiAreena,

2025a), creating a regional ecosystem, a value chain requires collaboration between companies.

“Of course, there is participating stakeholder hearings and discussion with relevant parties always whenever there is an opportunity to present both in national and EU level. Stakeholder cooperation and field consultation are a big part of the political process and an important part of law drafting, so it is essential to listen, discuss and consider what the common rational approaches to issues are.” (Interviewee 3)

“For us it is understanding the business opportunity. Tell that to the customer that here is this carrot now because those that would have the potential of capturing this opportunity, do not necessarily understand this and that we need to teach to the customers. And what is a good example is that it is important. This involves politics among others, we need to discuss to everyone why this (e-Fuels) is required. So, how would I say, if we create business that we also must talk to whom buys the fuel. But at this moment of operation, the price tag comes to the consumer, and they must also understand okay, now I am paying for this and a lot, why?” (Interviewee 6)

“That is why we are part of the national hydrogen cluster. [--]. Then of course, (we) are strongly part of European organizations, where we aim to gain insight into what are the main things that are being focused on in Brussels and which way they are evolving so that we also understand long-term impacts.” (Interviewee 11)

Finally, concluding the relevant findings regarding BMs, while lobby and industry groups are seen as a channel for common discussion of what are the mean opinions and ‘positions’ among their members, direct lobbying activities offer alternative method. Usually, it is the mix of two as the interviewee 9’s comments suggest. Most prominently, lobbying results in competitive advantage by initiating a market, establishing industry logics and allowing to engage with it before competition does. The case of Neste lobbying and entering biofuels was mentioned repeatedly on many occasions, such as by three interviewees, 1-on-1 talks with ex-Neste employees, and news coverage (e.g. Mäntylä, 2025). Considering variety of firm strategies for engaging in the hydrogen-based business as mentioned earlier, lobbying also varies between how much firms do it. A direct activity includes having company representatives in lobby groups’ boards of directors or working groups on specific topics, and on other example, influencing policy making processes as

much as possible (Secondary data 2). Direct influencing including discussing with policy makers, as well as active engagement with industry groups, that are lobby groups since these have influence towards decision makers. Other tactics include position papers and public consultations part of legislating processes.

“Other firms have quite a lot of their own advocacy activities. They might be a bit more lenient. Some big corporations have headquarters somewhere, if it’s not in [country]. Many of the large ones typically have their own Brussels organization that focuses purely on influencing the EU.” (Interviewee 9)

“Yes, back when we were there, Neste was able to gain significant profits by lobbying and getting the biofuel mandates setup since competitors were lagging behind in (entering) biofuels.” (Coffee discussion)

“When they set up the biofuel mandates in EU in 2008-2009 at 10%, [--]. In Finland a 20% mandate was made. And I see that it was in greatly significant role that the industry was born in Finland. UPM invested, and Neste had invested earlier and grew like into larger globally.” (Interviewee Anonym.)

“You have these large organizations, you have the quality management to regulate and also you do this advocacy with the political decision makers. So, they have a huge base business. They understand the grey hydrogen today in their markets because hydrogen is the key business in industrial gases. So, they’re well set up for that game because they have the organization also all the knowledge in place to understand hydrogen from its very basics.” (Interviewee 5)

4.4 Summary of the results

The study’s goal was to understand how firms sustain competitive advantage by understanding environmental regulation in the renewable hydrogen industry, with business model innovation impact on competitive advantage the main theoretical lens. **The figure 12** presents the findings under the revised theoretical framework, the empirical findings are inside the dash lined boxes.

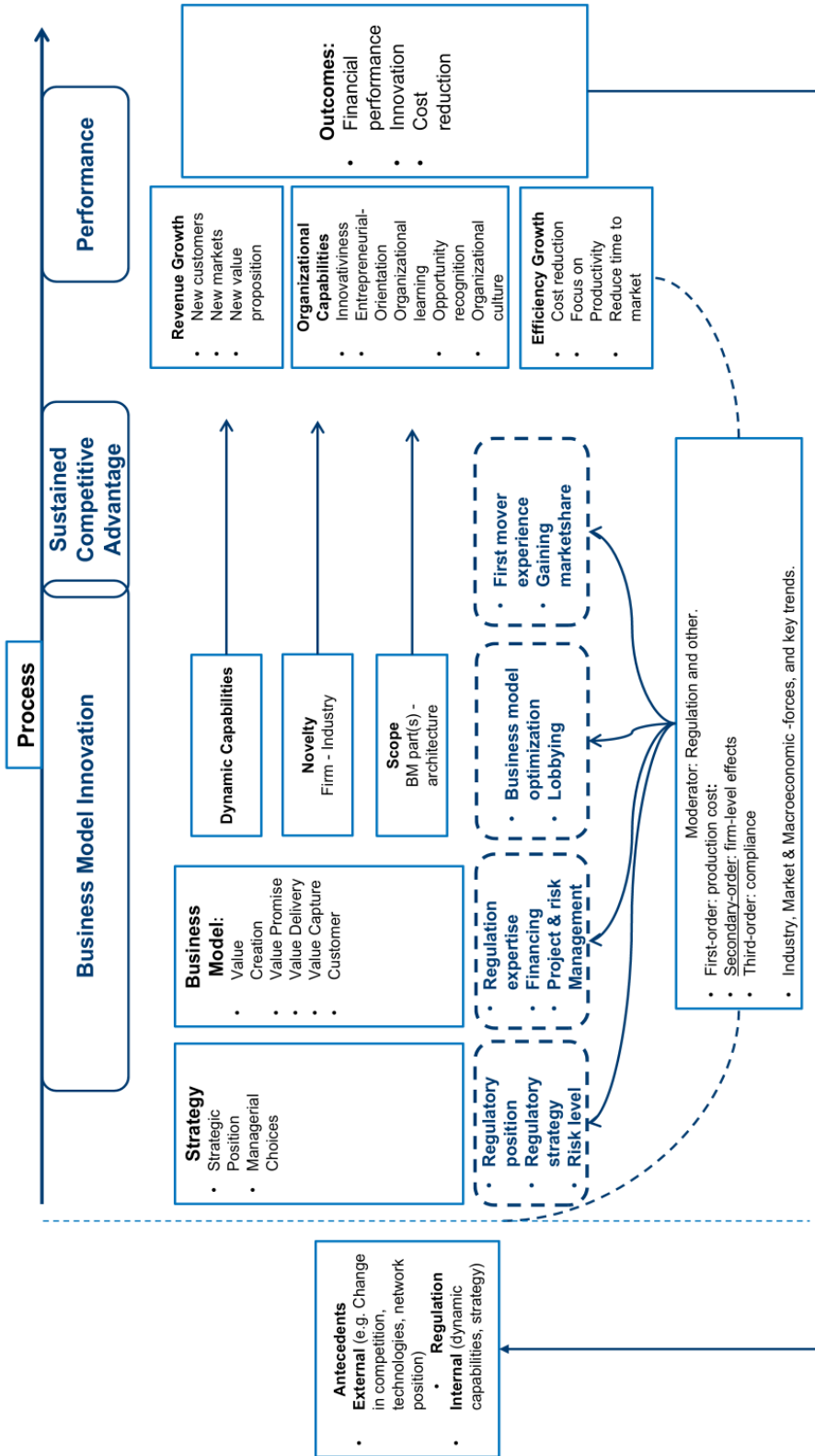


Figure 12. Revised theoretical framework.

5 Discussion

The final chapter of the study consists of the discussion and recommendations of this study. Firstly, theoretical discussion on regulation's meaning for business model innovation and competitive advantage is focused on. Secondly, managerial implications for both general public and the case company are discussed. Thirdly, policy recommendations are presented.

5.1 Theoretical contribution

Gioia states that theoretical contributions arise from development of novel concepts and/or their relationship among the concepts helping to understand the phenomena, that is theory (Gehman et al., 2018, p. 290). Foremost, contributions address the research question and gap. First, the study contributes with in-depth look into environmental regulation's impact for business, strategy, and business model innovation, altogether competitive advantage. While scholars argue business model is result of strategy and a source competitive advantage (e.g., see Teece, 2018; Casadesus-Masanell & Ricart, 2010; Foss & Saebi, 2017), and others suggest BM and strategy are combined (e.g., see Bigelow & Barney, 2021). It is safe to argue that where firms seek advantage from regulation, decree of regulatory context dictates impact on firm level strategy, and the findings suggest especially in regulation driven markets. Furthermore, the study supports the current trend of holistic sociotechnical transitions requiring firms to innovate as whole (Bidmon & Knab, 2018; Lüdeke-Freund et al., 2024) and suggest environmental regulation catalyst strategy before shaping business model. However, the findings support that regulation is antecedent of BMI in incumbent process industries.

Regulation offers competitive advantage more than when it is only an antecedent of change, business model innovation (Rabetino et al., 2025; Foss & Saebi, 2017). Understanding, influencing and engaging with regulation is a core part of realizing the BMI process towards implications for one's business model. Gaining competitive advantage

is result of managerial process (Kouamé & Langley, 2018), as much as it is utilizing dynamic capabilities (Teece, 2018; Bigelow & Barney, 2021). Therefore, it safe to argue regulation is useful for competitive advantage as much as managers are capable realizing it. However, as said, this resembles the basic function and meaning of dynamic capabilities: sensing, seizing, and transforming. Rather, the findings demonstrate that firm's resources, capabilities and managerial decisions contribute to actualizing firm strategy into business model innovation. The findings support the thesis' theoretical stance: regulation drives strategic orientation, which in turn guide BMI choices and ultimately firm performance, with occasional direct regulation to business model effects. This causal view integrates strategy, regulatory capability, and BM design into one framework.

Massa et al. (2017, p. 95) call for how much ecosystem explains BMI performance, the study contributes by explaining regulation's role as an indicator on how value system emerges in the sustainable transition, that is regulation driven. While key challenge is that hydrogen business relies on regulation being 'clear', the findings suggest it is the ecosystem's readiness where this clarity impacts, also contributing to explaining sector specific dynamics (Lüdeke-Freund et al., 2024, p. 147). Especially, according to Lanzolla and Markides (2021) high structural forces pose barrier to gain competitive advantage through unique BMI, while this study's findings suggest innovating process efficiency, that is value creation and delivery, emerges from successful business model optimization. That is, finding the right customer, optimizing value chain, but also, being able to manage financial capabilities and risk management. In conclusion, Bigelow and Barney (2021) suggest business models conceptualization as monetization/value capture conceptualization, and the findings suggest regulation moderates these logics.

Second, the findings support the Porter Hypothesis (PH) (Porter & van der Linde, 1995) that suggest in favor of strict environmental regulation increasing competitiveness and suggest that especially international competitiveness arises rather from practical inputs other than regulation such as ecosystem's viability to organizational inputs for strategy. However, the findings do also support the PH's weak version (Fabrizi et al., 2024, p. 170)

that environmental regulation acts especially as stimulus for production, value creation innovation in the greenfield industry of renewable hydrogen. In fact, the findings suggest strong environmental regulation supports innovations by providing predictability, investment stability, cost competitiveness by margin and demand certainty. These also support argument from Leisen et al. (2019) that suggest regulatory risk concern mainly revenue certainty on price, and I find that regulation also defines the customer as well as cross-sectoral barriers of innovation. Additionally, the Pollution Heaven hypothesis is trumped by suggesting that firms have incentive to continue doing business where they are located. Especially, when exit barriers are formed by high sunk costs in incumbent process industries, where sustainable transition can either be catalyzed by regulation but also by rising growth opportunities. The energy industry's ultimate barrier to exit is infrastructure.

5.2 Managerial implications

The most prominently the study contributes to managers in the emerging case industry, renewable hydrogen and fuels by synthesizing regulation's strategic impact. Regulation offers beyond the general industry logic for competitiveness from technology and effectiveness optimization. Especially, the study suggests partnerships offer a way to mitigate industry forces. Because different value chain parts hold different risk levels and barriers of entry vary between in process industries. Especially, a profound understanding of one's own business and what a partnership has to offer is required for successful assessment. Achieving feasibility, over down high risk and understanding one's own competitive position contribute to managing risk levels between different value chain stages.

Secondly, more broadly, managers can improve their business, strategy and business models in variety of ways from understanding regulation. While regulation is an external constraint itself, the ability to understand and adapt it part of business models, can allow to gain competitive advantage. Especially, understanding viable product solutions and specific customer segments. By predicting and influencing how regulation folds, firms

can pave their future business opportunities before competition matches those. Essentially, lobbying is powerful tool of securing strategy by decreasing business risks in regulation's reliability. Especially, lobbying is everyday business in regulation driven industries. At the core level of strategizing, capabilities to understand regulation and realize business on that becomes essential. Finally, since regulation holds political risk, managing strategic decision from the risk management perspective is part of every firm's strategy. Moreover, solutions to the various risks, challenges and barriers advocate risk management.

5.3 Policy recommendations

The author gained significant insight into hydrogen policy and decision-making processes in the European Union, especially a diverse cross-sectoral perspective. Therefore, policy recommendations are given. First, national policy makers should offer the information of regulation and legislating processes in English and other relevant languages. The financing streams for renewable fuels' projects are global, and therefore clear regulative information is evitable in order to attract foreign capital. Foremostly, governments offer legitimate and trustworthy authority on information since they are responsible for legislation. The issue emerged especially during the tracking process of the RED III national transpositions, and even with holistic updates from industry groups such as Hydrogen Europe, actual contents of national laws are often available only in national language.

Secondly, foremostly, the green transition into e-Fuels in sectors such as maritime and aviation, requires long-term trustworthiness from policy makers. Therefore, contracts for difference offer robustness for the offtake of first mover projects in comparison to supply mandates that are subject to election volatility. Climate policies such as the European Green Deal targets 2050 for achieving carbon neutrality but the early-mover uncertainty present unbearable barrier for e-Fuel adaptation. Especially, the findings support Liesen et al. (2019) that suggest niche innovation require strict price setting regulation.

5.4 Suggestion for future research

The emerging status of the renewable fuels industry and sustainable development offer opportunity for longitudinal case study regarding how firm performance is affected by regulation. The transition from fossils to renewables offers decades of business opportunities and innovation to be researched, from variety of perspectives. For the study's topic, business model innovation and competitive advantage, regulation's long-term impacts on business will be relevant by topics such as regulation's reliability, global competitiveness and correlation towards financial performance. Especially, how regulation is moderating between first mover advantages and sustained competitive advantage, and how business model innovation impacts in between. Furthermore, longitudinal study on hydrogen regulation would call on Bigelow and Barney's (2021) suggest for long-standing challenges in strategic management.

Secondly, a multiple case study between different industries, regulated fields. Although, regulation is context dependent, comparing between different fields could give rigor towards general strategic management literature. Comparison between sectors such as banking, medical industries and energy industries provide avenues for comparative case study. Not to forget a comparison of industries between different geographies and their contribution to global competition. Especially, the climate change is a global challenge requiring contribution from all nations. Combined with longitudinal performance study, this would also contribute to economics studies of environmental regulation's competitiveness. Moreover, greenfield industries offer novel avenue of competitiveness research from the dilemma between Porter Hypothesis and Pollution Heaven hypothesis, where competition between fossils and renewables is one question but competition between different renewables offers another perspective. Especially, the renewable fuels have many potential solutions for the hard to abate, electrify industries, maritime and aviation.

5.5 Limitations

Despite the contributions on regulation's meaning for competitive advantage, the study holds certain limitations. Firstly, the interviews regarding the European Union's renewable hydrogen regulation give in-depth perspectives but may be too general and not apprehend hydrogen regulation's global scale. Foremost, national differences between EU member states also pose limitation, since national laws differ but also do industry characteristics. However, the European Union, specifically the European Commission hold legislating power over the member states, making it reliable source for study's focus. Regarding the sample of 11 interviewees is cross-sectoral, and secondary data was collected to enrich the data as mentioned in data collection. The interviewees represent variety of different sectors under the renewable hydrogen industry as mentioned. Regardless of the international and global perspectives given by multiple interviewees, the study lacks interviewees from other geographic areas outside the European Union. The geographic limitation's especially impact the reliability in terms of replicating the study in other parts of the globe but so does the context.

Secondly, the case industry, renewable hydrogen and e-Fuels is in emerging status and the regulation is evolving. The European Commission's RED III's RFNBO mandates become realized the latest in 2030, in less than 5 years of this study. None the less, the FuelEU Maritime's RFNBO mandate sets in action the latest in 2034, not to mention IMO's resolution for carbon reduction goals to be voted in October 2025. These highlight the cases industry's characteristics, regulation is ever evolving topic that what is found today in the results, could change when time progresses. For example, the USA's 2028 presidential elections in 3 years could bring alternative approach on the Trump Administration's climate trumping policies offering alternative of a comparative case study.

Additionally, the value chain analysis focuses on the general characteristics of RFNBO/e-Fuels/Hydrogen value system, without in-depth look into specific technical details, solutions, or technoeconomic analysis. However, the focus is on the general level

characteristics of the whole value system in holistic study, making detailed specific analysis irrelevant. Of course, if the analysis was to be comparison between different solutions, the technoeconomic analysis should be considered in detail.

Thirdly, the author worked in a technology-EPC solution provider company, Andritz's P2X business unit. This can be seen as challenge for mitigating bias. However, repeating the data collection, both the primary data and secondary data relied on external sources, with only 2 interviewees being from Andritz. A key limitation is the writer's subjective interpretivism from the EPC perspective. However, the grounded method aims to solve this, as well as collaboration with Andritz fast tracked the author's ability to gain understanding of the vast topic. Especially, the author's linkage to the company could have had both benefits and limitations when prospecting potential interviewees. Availability of interviewees willing to participate was limited due to the case topic's sensitivity. Relation to corporate strategy and competitive advantage, and the emerging status of the case industry limited sample group. Additionally, regulation relates to politics which could also limit interviewees' openness of expressing opinion, and cause bias. Although, the interviews with external stakeholders focused on open information, regulation and general industry aspects than corporate strategy in order to avoid competition/business cartel issues. Interviewee 4 recommended mentioning the sensitivity of strategy as topic of discussion that was acknowledged in the beginning of interviews in later interviews.

References

- Aagaard, A. (2024). *Business Model Innovation*. Springer International Publishing
- Andritz. (2024). *Integrated EPC solutions for e-methanol production*. Retrieved January 2025 from <https://www.andritz.com/power-to-x-en/offering-power-to-x/e-methanol>
- Andritz. (2025a). *Power 2 Profit: How to Make A P2X Project Pay Off*. Andritz AG. Retrieved March 2025 from <https://www.andritz.com/resource/blob/622452/fe39069380c7b9d1142cd324082fcc34/3505-andritz-white-paper-design-v5-data.pdf>
- Andritz. (2025b). *Fueling the future of maritime transport with e-methanol*. Retrieved 2025-07-04 from <https://www.andritz.com/power-to-x-en/use-cases/maritime-transport>
- Andritz. (2025c). *Annual Report 2024*. Andritz AG. Retrieved 2025-09-01 From <https://www.andritz.com/resource/blob/621030/dbee57fbbaa6c77724c2870c5e2743ff/andritz-annual-report-2024-web-data.pdf>
- Andritz. (2025d). *Internal Material: public relations & stakeholder communication document*.
- Amit, R., & Zott, C. (2012-03-01). Creating Value Through Business Model Innovation. *MIT Sloan management review*, 53(3), 41.
- Bhattacharyya, S. C. (2011). *Energy economics: Concepts, issues, markets and governance*. Springer.
- Bidmon, C. M., & Knab, S. F. (2018-03-20). The three roles of business models in societal transitions: New linkages between business model and transition research. *Journal of cleaner production*, 178, 903-916. <https://doi.org/10.1016/j.jclepro.2017.12.198>
- Bigelow, L. S., & Barney, J. B. (2021-03). What can Strategy Learn from the Business Model Approach? *Journal of management studies*, 58(2), 528-539. <https://doi.org/10.1111/joms.12579>

- Bowman, C., & Ambrosini, V. (2000-03). Value Creation Versus Value Capture: Towards a Coherent Definition of Value in Strategy. *British journal of management*, 11(1), 1-15. <https://doi.org/10.1111/1467-8551.00147>
- Budler, M., Župič, I., & Trkman, P. (2021-10-01). The development of business model research: A bibliometric review. *Journal of business research*, 135, 480-495. <https://doi.org/10.1016/j.jbusres.2021.06.045>
- Casadesus-Masanell, Ramon, and Joan Enric Ricart. "From strategy to business models and onto tactics." *Long range planning* 43, no. 2-3 (2010): 195-215.
- Chesbrough, H. (2010-04-01). Business Model Innovation: Opportunities and Barriers. *Long range planning*, 43(2), 354-363. <https://doi.org/10.1016/j.lrp.2009.07.010>
- Christensen, C. M. (2016-09-01). Know your customers: "jobs to be done". *Harvard business review*, 94(9), 54-62
- Commission Delegated Regulation (EU) 2023/1184. The European Parliament and the Council. Retrieved January 2025 from https://eur-lex.europa.eu/eli/reg_del/2023/1184/oj/eng
- Commission Delegated Regulation (EU) 2023/1185. The European Parliament and the Council. Retrieved January 2025 from https://eur-lex.europa.eu/eli/reg_del/2023/1185/oj/eng
- CNBC. (03-30-2024). *How Maersk Is Navigating the Volatile Shipping Industry*. CNBC. Retrieved April 2025 from <https://www.youtube.com/watch?v=Gwy6aJ48L5c>
- Dechezleprêtre, A., & Sato, M. (2017). The impacts of environmental regulations on competitiveness. *Review of environmental economics and policy*.
- Deloitte. (24-06-2024a). *Assessing the impact of low-carbon hydrogen regulation in the EU*. Deloitte. Retrieved January 2025 from https://www.deloitte.com/content/dam/assets-zone2/de/de/docs/issues/sustainability-climate/2024/Assessing_the_impact_of_low-carbon_hydrogen_regulation_in_the_EU_Deloitte.pdf
- Deloitte. (Nov-2024b). *Low-carbon fuels: The last mile to net zero*. Deloitte. Retrieved August 2025 from <https://www.deloitte.com/global/en/issues/climate/low->

carbon-fuels.html?icid=top_https%3Awww.deloitte.comglobalenissuesclimate-low-carbon-fuels.html

- Ding, C., Ferro, A., Fitzgibbon, T., & Szabat, P. (2022). Refining in the energy transition through 2040. *McKinsey & Company*. Retrieved 2025 from <https://www.mckinsey.com/industries/oil-and-gas/our-insights/refining-in-the-energy-transition-through-2040>
- Dolci, F., Gryc, K., Eynard, U., Georgakaki, A., Letout, S., Kuokkanen, A., Mountraki, A., Ince, E., Shtjefni, D., Joanny, G., Eulaerts, O., Grabowska, M., Clean Energy Technology Observatory: Water Electrolysis and Hydrogen in the European Union – 2022 Status Report on Technology Development, Trends, Value Chains and Markets. *Publications Office of the European Union*, Luxembourg, 2022, doi:10.2760/7606, JRC130683
- DNV. (2024). *Maritime Forecast to 2050*. Det Norske Veritas group. Retrieved April 2025 from <https://www.dnv.com/maritime/maritime-forecast/>
- Dulian, M., & Erbach, G. (2025). *Renewable and low-carbon hydrogen: State of play and outlook*. *The European Parliament. EPRS: European Parliamentary Research Service*. Belgium. Retrieved January 2025 from [https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/767227/EPRS_BRI\(2025\)767227_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/767227/EPRS_BRI(2025)767227_EN.pdf)
- Eisenhardt, K. M., & Graebner, M. E. (2007-02-01). Theory Building From Cases: Opportunities And Challenges. *Academy of Management journal*, 50(1), 25-32. <https://doi.org/10.5465/amj.2007.24160888>
- Eriksson, P., & Kovalainen, A. (2016). *Qualitative methods in business research* (2nd edition.). Sage Publications.
- Espitalier-Noel, M., Fonseca, J., Fraile, D., Muron, M., Pawelec, G., Santos, S., & Staudenmayer, O. (Nov-2024). Clean Hydrogen Monitor 2024. Hydrogen Europe. Retrieved January 2025 from https://hydrogeneurope.eu/wp-content/uploads/2024/11/Clean_Hydrogen_Monitor_11-2024_V2_DIGITAL_draft3-1.pdf
- The European Commission: Directorate-General for Mobility and Transport, Directorate-General for Climate Action, Directorate-General for Energy, De Vita, A., Capros, P., Paroussos, L., Fragkiadakis, K., Karkatsoulis, P., Höglund-Isaksson, L., Winiwarter,

W., Purohit, P., Gómez-Sanabria, A., Rafaj, P., Warnecke, L., Deppermann, A., Gusti, M., Frank, S., Lauri, P., Fulvio, F. d., ...Kalokyris, T., (2021). *EU reference scenario 2020: energy, transport and GHG emissions: trends to 2050*, Publications Office. <https://data.europa.eu/doi/10.2833/35750>

The European Commission. (2024a). *The Renewable Energy Directive*. Retrieved January 2025 from https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en

The European Commission. (2024b). *Communication From the Commission*. Retrieved 2024 from https://energy.ec.europa.eu/document/download/0c574279-b71d-4aa0-9403-daf9ea5a8491_en?file-name=C_2024_5042_1_EN_ACT_part1_v8.pdf

The European Commission. (2024c). *2050 long-term strategy*. Retrieved January 2025 from https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en

The European Commission. (2024d). *Decarbonising maritime transport – FuelEU Maritime*. Retrieved 27.01.2025 From https://transport.ec.europa.eu/transport-modes/maritime/decarbonising-maritime-transport-fueu-maritime_en

The European Commission. (2025a). *Questions and Answers on Regulation (EU) 2023/1805...* Retrieved 27.01.2025 from https://transport.ec.europa.eu/transport-modes/maritime/decarbonising-maritime-transport-fueu-maritime/questions-and-answers-regulation-eu-20231805-use-renewable-and-low-carbon-fuels-maritime-transport_en

The European Commission. (2025b). *IF24 Auction*. Retrieved from https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/calls-proposals/if24-auction_en

European Court of Auditors. (2024). *Special report: The EU's industrial policy on renewable hydrogen*. European Court of Auditors. Retrieved January 2025 from https://www.eca.europa.eu/ECAPublications/SR-2024-11/SR-2024-11_EN.pdf

- The European Parliament and the Council Directive. (2018). Directive (EU) 2018/2001 of the European Parliament and the Council. Retrieved January 2025 from <https://eur-lex.europa.eu/eli/dir/2018/2001/oj>
- The European Parliament and the Council Directive. (2023). Directive (EU) 2023/2413 of the European Parliament and the Council.; (Renewable Energy Directive III). Retrieved January 2025 from https://eur-lex.europa.eu/eli/reg_del/2023/2413/oj/eng
- ExxonMobil. (04-07-2025). *Annual Report to Security Holders*. Retrieved September 2025 from <https://investor.exxonmobil.com/sec-filings/annual-reports##document-5101-0000034088-25-000010-2>
- Fabrizi, A., Gentile, M., Guarini, G., & Meliciani, V. (2024-01). The impact of environmental regulation on innovation and international competitiveness. *Journal of evolutionary economics*, 34(1), 169-204. <https://doi.org/10.1007/s00191-024-00852-y>
- Flink, C., & Kuhn, M. (May 2025). *Unveiling the Myth of Bankability for Green Hydrogen Project Financing*. Hydrogen Europe. Retrieved May 2025 from https://hydrogeneurope.eu/wp-content/uploads/2025/05/2025.05_Unraveling-the-myth-of-banability-for-greenH2_HEpaper.pdf
- Fontagné, L., & Schubert, K. (2023). The economics of border carbon adjustment: rationale and impacts of compensating for carbon at the border. *Annual Review of Economics*, 15(1), 389-424.
- Foss, N. J., & Saebi, T. (2017-01-01). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? *Journal of management*, 43(1), 200-227. <https://doi.org/10.1177/0149206316675927>
- Foss, N. J., & Saebi, T. (2018-02-01). Business models and business model innovation: Between wicked and paradigmatic problems. *Long range planning*, 51(1), 9-21. <https://doi.org/10.1016/j.lrp.2017.07.006>
- Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018-10-10). Sustainable business model innovation: A review. *Journal of cleaner production*, 198, 401-416. <https://doi.org/10.1016/j.jclepro.2018.06.240>

- Gehman, J., Glaser, V. L., Eisenhardt, K. M., Gioia, D., Langley, A., & Corley, K. G. (2018-07-01). Finding Theory–Method Fit: A Comparison of Three Qualitative Approaches to Theory Building. *Journal of management inquiry*, 27(3), 284-300. <https://doi.org/10.1177/1056492617706029>
- Gibbert, M., Ruigrok, W., & Wicki, B. (2008-12). What passes as a rigorous case study? *Strategic management journal*, 29(13), 1465-1474. <https://doi.org/10.1002/smj.722>
- Giehl, J., Hohgräve, A., Lohmann, M., & Müller-Kirchenbauer, J. (2023). Economic analysis of sector coupling business models: Application on green hydrogen use cases. *International Journal of Hydrogen Energy*, 48(28), 10345-10358. <https://doi.org/10.1016/j.ijhydene.2022.12.173>
- Gioia, D. (2021-03-01). A Systematic Methodology for Doing Qualitative Research. *The Journal of applied behavioral science*, 57(1), 20-29. <https://doi.org/10.1177/0021886320982715>
- Granskog, A., Patel, M., Gupta, R., & Helmcke, S. (April, 2025). *How incumbents can succeed in climate-driven growth investments*. McKinsey & Company. Retrieved May 2025 from <https://www.mckinsey.com/capabilities/sustainability/our-insights/how-incumbents-can-succeed-in-climate-driven-growth-investments#/>
- Grodal, S., Anteby, M., & Holm, A. L. (2021). Achieving Rigor in Qualitative Analysis: The Role of Active Categorization in Theory Building. *The Academy of Management review*, 46(3), 591-612. <https://doi.org/10.5465/amr.2018.0482>
- Heikkilä, M., Bouwman, H., & Heikkilä, J. (2018-02-06). From strategic goals to business model innovation paths: An exploratory study. *Journal of small business and enterprise development*, 25(1), 107-128. <https://doi.org/10.1108/JSBED-03-2017-0097>
- Holmström, J., Ketokivi, M., & Hameri, A. (2009-02). Bridging Practice and Theory: A Design Science Approach. *Decision sciences*, 40(1), 65-87. <https://doi.org/10.1111/j.1540-5915.2008.00221.x>

- Hydrogen Europe. (2024). *Hydrogen Infrastructure: The Recipe for a Hydrogen Grid Plan*. Retrieved from https://hydrogeneurope.eu/wp-content/uploads/2024/10/2024.10_HE_Hydrogen-Infrastructure-Report.pdf
- Hydrogen Europe. (June 2025). *Guidance on REDIII implementation in the transport sector*. Hydrogen Europe. Retrieved from https://hydrogeneurope.eu/wp-content/uploads/2025/06/2025.06.02-Guidance-Note-RED-III-Transport-_for-website.pdf
- Karre, A. V. (2022). *Managing Engineering, Procurement, Construction, and Commissioning Projects: A Chemical Engineer's Guide*. John Wiley & Sons, Incorporated.
- Keiningham, T., Aksoy, L., Bruce, H. L., Cadet, F., Clennell, N., Hodgkinson, I. R., & Kearney, T. (2020-08-01). Customer experience driven business model innovation. *Journal of business research*, *116*, 431-440. <https://doi.org/10.1016/j.jbusres.2019.08.003>
- Kindström, D. (2010). Towards a service-based business model – Key aspects for future competitive advantage. *European management journal*, *28*(6), 479-490. <https://doi.org/10.1016/j.emj.2010.07.002>
- Kontu, A. (2019). *Sustainable Competitive Advantage in the Industrial Service Business*. Vaasan yliopisto.
- Kouamé, S., & Langley, A. (2018-03). Relating microprocesses to macro-outcomes in qualitative strategy process and practice research. *Strategic management journal*, *39*(3), 559-581. <https://doi.org/10.1002/smj.2726>
- Kraus, S., Filser, M., Puumalainen, K., Kailer, N., & Thurner, S. (2020). Business model innovation: A systematic literature review. *International Journal of Innovation and Technology Management*, *17*(06), 2050043. <https://doi.org/10.1142/S0219877020500431>
- Lanzolla, G., & Markides, C. (2021-03). A Business Model View of Strategy. *Journal of management studies*, *58*(2), 540-553. <https://doi.org/10.1111/joms.12580>
- Latifi, M., Nikou, S., & Bouwman, H. (2021-09-01). Business model innovation and firm performance: Exploring causal mechanisms in SMEs. *Technovation*, *107*, 102274. <https://doi.org/10.1016/j.technovation.2021.102274>

- Linde. (n.d.). *Petrochemical processing and refining: Hydrogen in refining*. Linde. Retrieved January 2025 from <https://www.linde-gas.fi/shop/en/fi-ig/chemical-processing-and-refining#:~:text=We%20ofer%20a%20wide%20range%20of%20gas-related%20solutions,and%20software%20to%20support%20safety%20competence%2C%20for%20instance>.
- Liquid Sun. (2025). *Technology company Liquid Sun launches eSAF production pilot – with ABB, Finnair, Fortum, and Finavia*. Retrieved September 2025 from <https://www.liquidsun.co/news/esaf-production-pilot-with-abb-finnair-fortum-finavia>
- Länsisalo, E., Sivill, L., Patronen, J., Lottonen, J., Siitonen, J., & Ollus, F. (2025). *The use and promotion of renewable hydrogen in industry*. TEM: AFRY Oy. Retrieved January 2025 from https://tem.fi/documents/1410877/231218972/Uusiutuvan+vedyn+k%C3%A4ytt%C3%B6+ja+edist%C3%A4minen+teollisuudessa_loppu-raportti_200125.pdf/88ba8a8d-f53b-6281-b2ca-c41c661f77b5/Uusiutuvan+vedyn+k%C3%A4ytt%C3%B6+ja+edist%C3%A4minen+teollisuudessa_loppu-raportti_200125.pdf?t=1740133556091
- Lüdeke-Freund, Florian, Peter Wells, and Annabeth Aagaard. "The catalytic role of sustainability transitions for business models." *Business Model Innovation: Game Changers and Contemporary Issues*. Cham: Springer International Publishing, 2024. 127-155.
- Massa, L., Tucci, C. L., & Afuah, A. (2017). A critical assessment of business model research. *Academy of Management annals*, 11(1), 73-104. <https://doi.org/10.5465/annals.2014.0072>
- Massa, L. (2024). The design of business models: What, how and why. *Journal of business models*, 12(1), 4-20. <https://doi.org/10.54337/jbm.v12i1.8401>
- Mazaheri, M., Bonnin Roca, J., Markus, A., & Walrave, B. (2022-11-01). Market-based instruments and sustainable innovation: A systematic literature review and critique. *Journal of cleaner production*, 373, 133947. <https://doi.org/10.1016/j.jclepro.2022.133947>

- Mitchell, D., & Coles, C. (2003-10-01). The ultimate competitive advantage of continuing business model innovation. *The Journal of business strategy*, 24(5), 15-21. <https://doi.org/10.1108/02756660310504924>
- Migliavacca, G., Carlini, C., Domenighini, P., & Zagano, C. (2024-10-01). Hydrogen: Prospects and Criticalities for Future Development and Analysis of Present EU and National Regulation. *Energies (Basel)*, 17(19), 4827. <https://doi.org/10.3390/en17194827>
- Motola V., Buffi M., Scarlat N., Hurtig O., Georgakaki A., Letout S., Mountraki A., Tattini J. and Schmitz A. (2023). Clean Energy Technology Observatory: Renewable fuels of non-biological origin in the European Union - 2023 Status Report on Technology Development, Trends, Value Chains and Markets, Publications Office of the European Union, Luxembourg, doi:10.2760/998267
- Müller, J. M., Buliga, O., & Voigt, K. (2018-07-01). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological forecasting & social change*, 132, 2-17. <https://doi.org/10.1016/j.techfore.2017.12.019>
- Mäntylä, J.M. (29.6.2025). *Palaako Neste vuolemaan kultaa?* Yle. Retrieved 1.8.2025 from <https://yle.fi/a/74-20166953>
- Möller, P. (2023). *Global Freight Transport Statistics: International, Europe, and Germany*. DHL. Retrieved April 2025 from <https://dhl-freight-connections.com/en/trends/global-freight-transport-statistics-international-europe-and-germany/>
- Nag, R., Corley, K. G., & Gioia, D. A. (2007-08-01). The Intersection of Organizational Identity, Knowledge, and Practice: Attempting Strategic Change Via Knowledge Grafting. *Academy of Management journal*, 50(4), 821-847. <https://doi.org/10.5465/amj.2007.26279173>
- Nemmour, A., Inayat, A., Janajreh, I., & Ghenai, C. (2023-09). Green hydrogen-based E-fuels (E-methane, E-methanol, E-ammonia) to support clean energy transition: A literature review. *International journal of hydrogen energy*, 48(75), 29011-29033. <https://doi.org/10.1016/j.ijhydene.2023.03.240>

- Neste Oyj. (28-02-2025). *Annual Report 2024: Change Runs on Renewables*. Retrieved from https://www.neste.com/files/pdf/3kFaGuHcQk8hRDLS6tlvqF-Neste_Annual_Report_2024.pdf
- OECD. (31-03-2025). *The Ocean Economy to 2050*. Retrieved May 2025 from https://www.oecd.org/en/publications/the-ocean-economy-to-2050_a9096fb1-en.html
- Oliveira-Dias, D., Kneipp, J. M., Bichueti, R. S., & Gomes, C. M. (2022-12-19). Fostering business model innovation for sustainability: A dynamic capabilities perspective. *Management decision*, 60(13), 105-129. <https://doi.org/10.1108/MD-05-2021-0590>
- Osterwalder, A., Clark, T., & Pigneur, Y. (2010). *Business Model Generation*. Wiley
- Pieroni, M. P., McAloone, T. C., & Pigosso, D. C. (2019-04-01). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of cleaner production*, 215, 198-216. <https://doi.org/10.1016/j.jclepro.2019.01.036>
- Porter, M. E. (1991). Towards a Dynamic Theory in Strategy. *Strategic Management Journal*, 12. 95-117.
- Porter, M. E., & van der Linde, C. (1995-10-01). Toward a New Conception of the Environment-Competitiveness Relationship. *The Journal of economic perspectives*, 9(4), 97-118. <https://doi.org/10.1257/jep.9.4.97>
- Pingkuo, L., & Junqing, G. (2024-09-26). Comparative analysis on the development potential of green hydrogen industry in China, the United States and the European Union. *International journal of hydrogen energy*, 84, 700-717. <https://doi.org/10.1016/j.ijhydene.2024.08.298>
- Quarton, C. J., & Samsatli, S. (2021-07). How to incentivise hydrogen energy technologies for net zero: Whole-system value chain optimisation of policy scenarios. *Sustainable production and consumption*, 27, 1215-1238. <https://doi.org/10.1016/j.spc.2021.02.007>
- Rabetino, R., Kohtamäki, M., Foss, N. J., Rahman, N., & Huikkola, T. (2025-07). Micro-foundations for business model innovation: Exploring the interplay between

- individuals, practices, and organizational design. *The Journal of product innovation management*, 42(4), 704-736. <https://doi.org/10.1111/jpim.12784>
- Richie, H. (2020). *Sector by sector: where do global greenhouse gas emissions come from?* Our World Data. Sourced from <https://ourworldindata.org/ghg-emissions-by-sector>
- Ritter, T., & Lettl, C. (2018-02-01). The wider implications of business-model research. *Long range planning*, 51(1), 1-8. <https://doi.org/10.1016/j.lrp.2017.07.005>
- Saunders, M., Lewis, P., & Thornhill, A. (2023). *Research methods for business students*. Pearson Education.
- Schwartz, D. (2024). *EPC vs EPCM – What is the difference?* ConstructionFront.com. Retrieved February 2025 from <https://constructionfront.com/epc-vs-epcm/>
- Shao, S., Hu, Z., Cao, J., Yang, L., & Guan, D. (2020). Environmental Regulation and Enterprise Innovation: A Review. *Business strategy and the environment*, 29(3), 1465-1478. <https://doi.org/10.1002/bse.2446>
- Sipilä, E., Lilja, A., Poikolainen, H., Ogata, T., & Kalliovalkama, S. (2023). *Liikenteen uusiutuvien polttoaineiden jakeluvaikejärjestelmän uudistaminen: RED III direktiivimuutoksen kansallinen toteutus ja vaikutusarviot*. Valtioneuvoston kanslia. Finland. Retrieved March 2025 from <https://urn.fi/URN:ISBN:978-952-383-011-0>
- Sjodin, D., Parida, V., Jovanovic, M., & Visnjic, I. (2020-03). Value Creation and Value Capture Alignment in Business Model Innovation: A Process View on Outcome-Based Business Models. *The Journal of product innovation management*, 37(2), 158-183. <https://doi.org/10.1111/jpim.12516>
- SuomiAreena. (2025a). *Teollisuuden vetyloikka - arvoketjut vauhdittamassa murrosta*. MTV. Retrieved May 2025 from <https://www.mtv.fi/video/7feaa48e8e55b5dc9d58/jakso-83-teollisuuden-vetyloikka-arvoketjut-vauhdittamassa-murrosta>
- SuomiAreena. (2025b). *Raha ratkaisee – mistä löytyvät Suomen vetytalouden miljardit?* MTV. Retrieved May 2025 from

- <https://www.mtv.fi/video/c52335d290aeabb6a1df/jakso-84-raha-ratkaisee-mista-loytyvat-suomen-vetytalouden-miljardit>
- Teece, D. J. (2010-04-01). Business Models, Business Strategy and Innovation. *Long range planning*, 43(2), 172-194. <https://doi.org/10.1016/j.lrp.2009.07.003>
- Teece, D. J. (2018-02-01). Business models and dynamic capabilities. *Long range planning*, 51(1), 40-49. <https://doi.org/10.1016/j.lrp.2017.06.007>
- Tholen, L., Leipprand, A., Kiyar, D., Maier, S., Küper, M., Adisorn, T., & Fischer, A. (2021-11-01). The Green Hydrogen Puzzle: Towards a German Policy Framework for Industry. *Sustainability*, 13(22), 12626. <https://doi.org/10.3390/su132212626>
- Transport & Environment. (2022). *Less is more: Regional shipping policy and global decarbonization*. Retrieved from https://www.transportenvironment.org/uploads/files/COP27_world_country_MRV-3.pdf
- Wirtz, B. W., & Daiser, P. (2018-01-01). Business Model Development: A Customer-Oriented Perspective. *Journal of business models*, 6(3), 24-44 <https://www.proquest.com/scholarly-journals/business-model-development-customer-oriented/docview/2407765893/se-2>
- Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). Sage publications.
- Zhang, Y., & Shaw, J. D. (2012). Publishing in AMJ—Part 5: Crafting the methods and results. *Academy of Management Journal*, 55(1), 8-12. <https://doi.org/10.5465/amj.2012.4001>
- Zhang, X., Antonialli, F., Bonnardel, S. M., & Bareille, O. (2024). Where business model innovation comes from and where it goes: A bibliometric review. *Creativity and innovation management*, 33(2), 109-126. <https://doi.org/10.1111/caim.12558>
- Zott, C., & Amit, R. (2007-03-01). Business Model Design and the Performance of Entrepreneurial Firms. *Organization science (Providence, R.I.)*, 18(2), 181-199. <https://doi.org/10.1287/orsc.1060.0232>
- Zott, C., Amit, R., & Massa, L. (2011-07-01). The Business Model: Recent Developments and Future Research. *Journal of management*, 37(4), 1019-1042. <https://doi.org/10.1177/0149206311406265>

Zott, C., Amit, R., & Giesen, E. (2024). Business Model Innovation Capability: A Game Changer for Sustaining a Firm's Edge. In *Business Model Innovation: Game Changers and Contemporary Issues* (pp. 27-56). Cham: Springer International Publishing.

Appendix

Appendix 1. Reference guiding document

Thesis Interview, Guiding Document

Aleksi Aaltonen, University of Vaasa

15.5.2025

Guiding Document

This document provides example on how interviewees are mentioned, referenced and cited in Aleksi Aaltonen's master's thesis regarding competitive advantage and renewable hydrogen regulation. The document's purpose is to clarify uncertainty regarding recording the interviews and how the given answers are used. The interviews provide the primary data for the thesis. The interviewees are encouraged for open discussion since the study can result in novel contributions to strategic management literature, hydrogen industry and business.

1.1 Reference example

The following table demonstrates how participants are mentioned in the thesis' appendix – the interview transcripts are not included.

Interviewee	Position	Relevant experience in years	Length
1	CEO	15	60 min
2	Director	20	65 min
3	Director	5	55 min
4	Vice President	25	1h 20 min
5	Consultant	15	1h 30 min
6			

The interviewees are numbered to distinct citing between. Foremost, most interviewees' positions are categorized into general categories. Executive position are as they are, but others are generalized. For example, product owner would be 'manager', and so would public affairs manager be 'manager', but a 'Public affairs vice president' would be mentioned only as 'vice president'.

1.2 Citation example

The interview results are discussed part of the findings chapter. The chapter's goal is to build answer for the research questions, and overall, the findings chapter builds around the theoretical framework.

Example:

'The first section of the findings presents regulation's relevance for the case industry, renewable hydrogen. The interviewees strongly advocate regulation's importance for the whole industry.

"Understanding the regulation is a must in order to participate and operate in this industry at all." (Interviewee 1)

"The whole industry builds up on regulation, and foremostly, every firm's strategy will begin and base on the regulation" (Interviewee 3)

However, although regulation is recognized as the driving force on how firms adapt strategy, approaches vary a lot between firms.

"We have seen that how firms approach regulation distinct into two groups. Firstly, there are proactive players towards both the actual business and policy makers. Secondly, the opposing group are rather reactive players that want to see what happens and play it safe." (Interviewee 5)

Appendix 2. List of interviewees

Inter- viewee	Position	Relevant experience in years	Duration
1	CEO	15	Written answers + 58 min
2	Director	20	65 min + 50 min
3	Director	4	55 min
4	Senior Specialist	15	67 min
5	Consultant	+20	1 h 44 min
6	Director	20	56 min + 51 min
7	Chairman of the Board	+25	57 min
8	Vice President)1*	15	57 min
9	Senior Specialist	+11	1 h 17 min
10	Consultant	+10	1 h 39 min
11	Vice President	25	44 min 39 s

1* A joint interview with interviewee 7.

Appendix 3. Interview questions and guide - general

Background Information

Topic: RED III & RFNBO-fuels

Interviewee:

Place and Time: Microsoft Teams; Length & date.

Context: renewable hydrogen regulation (e.g. Renewable Energy Directive, Delegated Acts, Jakeluvvoitelaki) define what are renewable fuels and foremostly, create the offtake demand and market for them. Every firm must understand regulation's impact on their own business if they want to participate in the renewable fuels industry ranging from electricity supplying to end-use demand.

Case: The study's case company, Andritz offers integrated P2X solutions for the production of renewable hydrogen, e-methanol and e-ammonia. The services range from engineering consulting to holistic Engineering, Procurement and Construction (EPC) project delivery as well as plant life-cycle services.

General Introduction

1. What is your company and position?
2. Could you talk about your background?
3. How familiar are you with the hydrogen regulation? How do you approach regulation?

Identifying regulation.

4. What does the regulation mean for the hydrogen economy?
5. What challenges does the regulation pose to you?
 - a. How have you solved these challenges?
6. What opportunities does the regulation present for you?
7. How does regulation impact [interviewee's sector's] business?
8. How could Andritz help its customers with overcoming the challenges and capturing opportunities?

9. How does the existing regulation support final investment decisions into P2X plants?
10. How should regulation support final investment decisions into P2X plants?

EPC-Regulation and Business Model (background material)

11. What do you think of the EPC-regulation business model? (actual model presented during interview)
12. How could EPC- and technology providers help with regulation regarding _?
 - a. Understanding its meaning for different stakeholders' business
 - i. Offtake case and project viability
 - ii. Risk management
 - b. Certification solutions
 - c. Standardized production and quality procedures
 - d. Scalable EPC-project models.
13. How could regulation mediate strategic choices? (e.g., degree of outsourcing development, partnerships).
14. Anything additional to mention regarding the topic?

What if questions... for clarification and brainstorming

Appendix 4. Secondary data sources

S.NO	Source	Type	Position	Details	Time
1	Lobby group.	Interview	Specialist	Policy implementation. February 2025.	59 min
2	Lobby group	Lobbying	Industry Representative	Policy implementation. March 2025.	1 h 30 min
3	FITECH & The Finnish Hydrogen Cluster.	Public webinar	Four industry expert guests	Hydrogen Economy: The Clean Industrial Deal's Impacts.	42 min
4	ICPEI Hydrogen.	Public webinar	Four industry expert guests	RFNBO Certification. 11 th of April 2025.	1 h 30 min
5	Internal	Workshop meetings & interviews.	Business Development (BD) Vice President, 2x BD manager, BD director & consultant.	Strategic planning: regulatory analysis, market modelling. March, April & May 2025.	+25 h
6	Expert	Workshop	BD manager & consultant.	Regulation & strategy discussion. January-February 2025.	5 h
8	Internal	Workshop & discussion	2x BD manager, consultant.	Certification Portfolio Development. 4 th of June 2025.	3 h 35 min
9	Hydrogen Europe.	Public webinar/Panel discussion	2x public officials, oil & gas specialist, H2 production specialist, & a technology consultant from the USA.	REDIII transport sector implementation. 5 th of June 2025.	1 h 30 min
10	Hydrogen Europe.	Public webinar	Member of the European parliament, SSAB, Farming industry,	Lead markets, creating the European demand for renewable hydrogen. 3 th of July 2025.	1 h 30 min

Appendix 5. Cross-analysis matrix's example in Microsoft Excel

First-order concept	Interviewee	1	2	3	4	5	6	7	8	9	10	11	SUM
Capex management			X			X	X	X			X		5
Fossil competition		X		X				X			X	X	5
Regulation predictability					X			X	X	X	X		5
Regulatory volatility				X	X			X	X	X			5
Market modelling		X		X		X	X	X			X		6
Marginality		X	X	X	X						X	X	6
Customers/Consumers				X	X		X	X	X	X			6
Offtake market			X									X	2
Risk Avoidance				X	X	X		X	X		X		6
Cost competitiveness			X	X		X	X	X	X		X		7
Infrastructure readiness					X					X		X	3
Investment conditions			X								X		2
First Mover Advantages			X			X							2
Product standards						X					X		2
Industry Standards				X		X					X	X	4
Market Dynamics			X	X				X			X		4
Customer regulation dialogue						X	X					X	3
Hard to copy						X							1
Technology ownership			X			X	X	X		X	X		6
Levelized Demand										X			1
Bankability			X	X		X	X	X	X		X	X	8
													0
First Mover Disadvantage				X			X		X		X		4
First Mover Risk advantage									X	X			2
Feasibility with mandates			X	X	X	X	X				X	X	7
LCOT		X		X	X			X		X	X		6
Economies of scale		X	X	X	X	X	X	X	X		X		9
Long-term commitment				X				X	X		X		4
Lack of Benchmark							X		X		X		3
Greenfield investments											X	X	2
Investment location			X	x			X				X		4
Risk Management				X	X	X	X	X			X		6
Project optimization		X									X		2
Field of competition		X	X			X					X		4
Technology maturity		X											1
Network Interdependencies					X	X	X	X	X		X		6
Technology Partnerships			X			X	X				X		4
Infrastructure Interdependency				X	X			X	X	X	X	X	7